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AN EXAMINATION OF *Dr.* BURNET'S *Theory of the Earth*:

WITH SOME
REMARKS
ON
Mr. WHISTON's *New Theory of the Earth.*
ALSO
An Examination of the Reflections on the
THEORY of the EARTH;
AND
A DEFENCE of the REMARKS on Mr. WHISTON's
NEW THEORY.

By *J. KEILL*, A. M. of *Balliol* College, OXON.

The SECOND EDITION *Corrected, and all the Figures*
(25 *in Number*) *Engraved on Copper Plates.*

To the whole is annexed a
DISSERTATION
ON THE
Different Figures of the *Cæleſtial Bodies*, &c.
With a Summary Expoſition of the *Carteſian* and *Newtonian* Syſtems.

By Monſ. *de MAUPERTUIS*, Fellow of the Royal
Society, and of the Royal Academy in *Paris*.

Printed for and Sold by H. CLEMENTS, near the Theatre in *Oxford*;
and S. HARDING, on the Pavement in St. *Martin's Lane*, *London*.

M DCC XXXIV.

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Reverend Sir,

THIS ſmall Treatiſe being the Product of ſome leaſure hours, I happily enjoy in a College that is under the kind influence of your Government, thinks it ſelf obliged to wait upon you, before it dares venture one ſtep further into the world. Its dreſs I freely own is mean: Nevertheleſs ſince the deſign of it is no other than to ſhew, that true Philoſophy doth not contradict the Scriptures, I am inclined to hope it will find a favorable acceptance among ſuch as have any Concern or Zeal for the advancement of the one, or the ſecurity of the other.

The Principles on which I have grounded my Arguments in the following diſcourſe being Mathematical, it doth more peculiarly belong to You, whoſe prudence in ſo Induſtriouſly promoting the Mathematical Sciences, both by your Direction and Encouragement I cannot ſufficiently Commend, when I conſider what vaſt improvements have been made, and how many Errors of former Philoſophers have been detected by applying Geometry to Natural Philoſophy.

I am ſenſible Sir, how unpleaſing it would be if I ſhould Addreſs my ſelf to

You in the uſual ſtile of Dedications. A prudent Zeal for the Authority of Scriptures, an Hearty Concern for the Rights of the Church, a Tender Care and Unwearied Induſtry in Promoting the Diſcipline, Learning, and Intereſt of an Antient Society, are Virtues which oblige the World to pay You thoſe Praiſes, which your Modeſty will not ſuffer you to receive. We, who live under the Advantages of theſe Excellent Qualifications in a Governor, cannot but be ſenſible of the Obligations we have to be thankful for them; and indeed the deſire of Expreſſing my Gratitude, for theſe Common and many other Particular Favors You have been pleaſed to beſtow on me, was the great motive of my preſuming to Inſcribe this Diſcourſe to your Name; which I deſire may be accepted as the reſult of Duty and Gratitude from,

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For *centrifugal force* (Pag. 91. *line* 9.) read *centripetal force*, as directed by Mr. *Keill* in Page 295.

ERRATA in the *Cœleſtial Bodies.*

Page 44. line 2. for $p \,.\, p :: \mathrm{AC}n$. read $p \cdot p' :: \mathrm{CA}^n$.

P. 45. l. 7. for $\frac{p \,.\, \mathrm{CG}^n + 1}{(n1 +)\,\mathrm{CA}^n}$ read $\frac{p \,.\, \mathrm{CG}^{n+1}}{(n+1)\,\mathrm{CA}^n}$

AN EXAMINATION OF Dr. BURNET's *Theory of the Earth.*

The Introduction.

WHAT *Plutarch* particularly proves of the *Stoicks*, that they ſpoke more improbabilities than the Poets, may be extended to a great part of Philoſophers, who have maintained opinions more abſurd than can be found in any of the moſt Fabulous Poets, or Romantick Writers. The one as well as the other fancied that their Character did oblige them to ſay things, which were not common or obvious to vulgar capacities, and therefore ſcorning the Inſtructions of ſenſe and reaſon, they only cultivated their own wild imaginations, which ſeldom produce any thing but what is extravagant and unaccountable. This will ſoon appear to any who will be at the pains to examin either the Ancient or Modern Philoſophers. To begin with the Ancients.

Which of the Poets did ever maintain ſo ridiculous an opinion, as that it is impoſſible for Bodies to move? And yet there have been Philoſophers (for ſo they were pleaſed to ſtile themſelves) who have brought arguments to prove motion to be a thing altogether impoſſible in nature, and have pretended that theſe their arguments almoſt reached the force of demonſtration. Is the Fable of *Leda*'s being firſt turned into a Swan, and afterwards placed in the Heavens as a fixed Star, more improbable than the opinion of *Anaxagoras*, that the *Circumambient Æther* being of a fiery ſubſtance by the vehement force of its whirling about did tear ſtones from the earth, and by its own power ſet them on fire and eſtabliſhed them as ſtars in the Heavens? *Diogenes* another Philoſopher ſaid that the Stars were like pumice Stones, and that they were the breathings of the world. But *Xenophanes* the founder of the *Eleatick Sect* ſays, they are compoſed of inflamed Clouds which in the day time are quenched, and in the night are kindled again, and that the riſing and ſetting of the ſtars, is nothing elſe but the kindling and quenching of them. *Anaximander* thought the Sun did very much reſemble the nave of a Chariot wheel, which is hollow and full of fire, the fire of which appears to us through its mouth, as by a pipe that is burning. And *Anaximenes* ſaid that when the Sun was eclipſed, the fiery mouth of it was ſtopp'd and hinder'd from perſpiration. *Heraclitus* tells us that the eclipſe of the Sun was after the manner of the turning of a boat, when the concave as to our ſight appears uppermoſt, and the convex neithermoſt. Another Philoſopher ſaid, that when the Sun was eclipſed, it was extinguiſhed. Theſe indeed are ſtrange notions, but yet they will ſeem much ſtranger if we conſider that theſe men lived after *Thales*, who had foretold an eclipſe of the Sun by his knowledge that the Moon was to be at ſuch a time in a direct line betwixt him and it. Such an averſion it ſeems theſe Philoſophers had to build upon other men's obſervations, that they would rather ſpeak unſufferable nonſenſe, than be at the pains to conſider what was obſerved before them by wiſer men than themſelves.

But who without indignation can hear the abovementioned *Xenophanes* maintain, that the earth was founded and rooted in an *infinite depth*, or *Epicurus* the *World-maker* aſſert, that the Earth was in the ſhape of a Drum, and that we dwell upon the plain ſurface of it, tho', long before either of their times, it was demonſtrated by the Mathematicians, that the Earth was of a ſpherical figure, and they had given rules to take the dimenſions of it? The ſame *Epicurus* affirms, in contradiction both to ſenſe and reaſon, that the Sun, Moon, and Stars are no bigger than they appear to us to be, and for any thing that he knew to the contrary, the Stars might be kindled in the Eaſt Quarter and extinguiſhed in the Weſt, or that there might be a new production of Stars every day, ſo that every day there aroſe a new Sun. I am ſure a Blind man, who had never ſeen either Sun or Stars, could not have given a worſe account of them, than this Philoſopher has done; and yet with an unpardonable boldneſs he pretended to tell us, how the World was made, when it is plain he knew not what it was.

He who deſires to know more of the wild notions of the old Philoſophers, may conſult *Diogenes Laertius*, or *Plutarch*'s Books of the ſentiments of Philoſophers.

But perhaps our Moderns will ſay, that theſe indeed were the ridiculous fancies of the old whimſical Philoſophers, and it is no great matter what they thought, but that now in this Learned and Inquiſitive Age they have at laſt found out the true and ſolid Philoſophy. They do now perceive the *intimate eſſence* of all things, and have diſcovered Nature in all her works, and can tell you the true cauſe of every effect, from the ſole principles of *matter and motion.* If you will believe them, they can inform you exactly, how God made the World; for they do now comprehend the greateſt myſteries in nature, and underſtand the Oeconomy of living Bodies: Nay they underſtand alſo very exactly the *Theory* of the Soul, how it thinks, and by what methods it operates on the Body, and the Body on it. Theſe indeed are great diſcoveries, and might well demand our eſteem and admiration, if they were real. But that we may ſee how well they deſerve ſuch a Character, I will here ſet down ſome of their ſentiments, both as to the Intellectual and Natural Syſtem.

Spinoſa pretends to demonſtrate that there is but one individual Subſtance in the Univerſe, and that all particular beings are different modifications of the ſame ſubſtance. Another Philoſopher, *viz.* Dr. *More*, will have Souls, beſides the three dimenſions which belong to Bodies, to have a fourth, which he calls the Souls *eſſential ſpiſſitude*, by which it can contract or dilate it ſelf when it pleaſes. Mr. *Hobbs* thinks Incorporeal Subſtances a flat contradiction, and that therefore it is altogether impoſſible there ſhould be any ſuch. But a new * Philoſopher has much out-done any I have yet mentioned, in a Book lately Printed concerning Reaſon; there he aſſures us that there is but one univerſal Soul in the World, which is omnipreſent and acts upon all

*Dr. *Burthogge.*

all particular organized Bodies, and makes them produce actions more or leſs perfect in proportion to the good diſpoſition of their Organs, ſo that in Beaſts, that Soul is the principle of the ſenſitive and vital functions; in Men it does not only perform theſe, but alſo all other rational actions, juſt as if you would ſuppoſe a hand of a vaſt extenſion, and a prodigious number of fingers, playing upon all the Organ-pipes in the world, and making every one ſound a particular note according to the diſpoſition and frame of the pipe, ſo this Univerſal Soul acting upon all Bodies, makes every one produce various actions, according to the different diſpoſition and frame of their Organs. This opinion he as confidently aſſerts to be true, as other men believe that it is falſe; tho' it is impoſſible he ſhould any other way be ſure of it, but by Revelation, and I believe he will find but few that will take it upon his word.

Monſ. Malbranch the famous inquirer after Truth, having made a long and deep ſearch how the Soul comes to have its Ideas, has found out at laſt, that we perceive not the things themſelves, but only their Ideas, which the Soul ſees in God. "For ſays he, the
" Soul is united to God in a much ſtricter
" and more eſſential manner than ſhe is united
" to the Body; and this union is by his pre-
" ſence, ſo that it may be ſaid, that God is
" the

" the place of Spirits, as ſpace is the place " of Bodies. He tells us alſo, that ſince God " has the Ideas of all beings in himſelf, the " Soul muſt needs ſee what there is in God " which repreſents created beings; for Bo- " dies are not viſible of themſelves, they not " being able to act upon our mind, nor re- " preſent themſelves to it; therefore they " being unintelligible in their own Natures, " there is no poſſibility of ſeeing them, ex- " cept in that being, which contains them af- " ter an intelligible manner*. Bodies therefore and their properties are ſeen in God, ſo that a man who reads this Book does not really ſee the Book it ſelf, but only the Idea of it, which is in God. Is not a man now much the wiſer for this unintelligible jargon? I would fain know what the Author meant by his ſeeing every thing in God by its Idea, for I muſt confeſs that the oftner I read his long Illuſtration on this point, I underſtand it the leſs; and I know as little how I have my Ideas, as I did before. If he had told me that the Soul ſaw its Ideas under the Concave of the Moon's Orb, where they ſay *Plato* placed them, I could have had ſome ſort of confuſed notion of that manner of ſeeing, but this manner of ſeeing Ideas, is far beyond my imagination. I am ſure *that I can neither*

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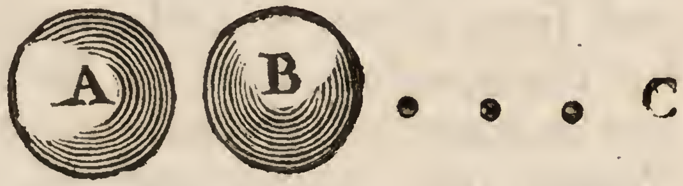
* *See the Preface and Page* 125. *firſt part, and Page* 147. *part ſecond.* Oxford *Edition.*

ſee the Idea of it in God, or any where elſe ; The truth is, I have not ſo couragiouſly reſiſted my ſenſes; as that Philoſopher adviſes, as to be able to penetrate ſuch a ſolid piece of nonſenſe.

The ſame Philoſopher affirms that Bodies of their own nature are neither heard, ſeen, ſmelt, nor taſted, and when for example we taſte any thing, the Body taſted cannot produce any ſavour in us, but God Almighty takes that occaſion to ſtir up that ſenſation in us, to which the body does not really concur. Nay according to him it is impoſſible for any man to move his own Arm, but when he is willing to move it, God takes it and moves it up and down, as the man, whoſe Arm it is, wills. If a Rebellious Son or Subject murther his Father or his Prince by ſtabbing him, the Man himſelf does not thruſt the Poiniard into his Father's or Prince's Breaſt, but God Almighty does it, without any other concurrence of the Man but his will. Theſe indeed are ſtrange and unaccountable fancies, But he proceeds ſtill further, and affirms that no ſecond cauſes act, ſo that no Body tho' moved with never ſo great a velocity againſt another can be able to drive that other before it, or move it in the leaſt, but God takes that occaſion to put it in motion. At this rate one need not fear his headpiece tho' a Bomb were falling upon it with all the force that Powder can give it, for it could not ſo much as break his Skull, or ſinge his hair, if God did not take that occaſion to do it. The moſt natural agents with him are not ſo much as inſtruments, but only occaſions of what is produced by them, ſo that a man might freely paſs thorough the fire, or jump down a precipice without any harm, if God Almighty did not take that occaſion to burn him, or daſh out his brains.

To prove that our moderns are as wild, extravagant, and preſumptuous as any of the Ancients either Poets, or Philoſophers, I may inſtance in Dr. *Conner*, whoſe imagination has taken a flight beyond the ſpheres of ſenſe and reaſon. Other Philoſophers were only ambitious to explicate nature, and the common effects of it, but no leſs a ſubject can ſatisfy him, than the Omnipotent Author of nature, and his extraordinary and miraculous acts, which he pretends to explain, for he thinks he underſtands them as well as he does the common Phænomena of Nature. This I believe will be granted him without much difficulty, for there is very good reaſon, to believe, that the works of Nature, are as much hid from him, as the myſteries of it, which he treats of, are from others. And tho' he talks that he has well conſidered the Laws of motion, and the force of Nature, yet it is plain that he knows not how to determine what proportion of motion there is in two bodies whoſe bulks and velocities are given. One can neither be the wiſer or better for what he has written, except to be convinced of the reaſonableneſs and excellency of modeſty and humility, ſeeing his attempts are as unſucceſsful, as they are ſhamefully impudent. And yet his Book muſt have the Sacred name of *Evangelium* prefixt to it, for which the Divines ſhould ſeverely Chaſtiſe him, to whom I leave him.

But M. *Des Cartes* the great Maſter and deliverer of the Philoſophers from the tyranny of *Ariſtotle*, is to be blamed for all this, for he has encouraged ſo very much this preſumptuous pride in the Philoſophers, that they think they underſtand all the works of Nature, and are able to give a good account of them, whereas neither he, nor any of his followers, have given us a right explication of any one thing. So ridiculous are the things he has delivered in his principles of Philoſophy, that it is a wonder how they ſhould be believed by any, but it is ſtill a greater wonder how they came to be ſo much applauded and received among the Learned, as they were. I will here ſet down ſome of the ſtrange Schemes and unaccountable fancies of this Philoſopher. He aſſures that there is always the ſame quantity of motion in the World, ſo that if all the Men and Animals in the World were moving, which moſt part of them can do when they pleaſe, yet ſtill there would be no more motion in the World than there is in the night time when they are at reſt, and what motion they had when they were moving, muſt be communicated to the Æther when they are at reſt. Another opinion of his about motion, as ſtrange as the former, is this, if there be two contiguous Bodies, A and B; and if B, were carried towards C, by the



very ſame Action A is transferred from B; ſo that there is an equal quantity of motion, and action, in both, tho' to all men's ſenſes, the body A ſeems not to be moved at all. Another law of motion, as contrary to ſenſe as any of the former, is; that if there be two bodies, one of which is bigger, tho' by a very little than the other, the leſſer, tho' moved with never ſo great a velocity againſt the former, which is at reſt, can never put it in motion. Notwithſtanding theſe and many other of his abſurd notions, he had a ſtrong party of the Philoſophers on his ſide, and great was the outcry againſt *Ariſtotle*, for his tyrannical uſurpation of the liberty and property of the Philoſophers to think and ſay what they had a mind; tho' what they ſaid was much more abſurd than *Ariſtotle*'s ἐντελέχεια, or the Schoolmen's men's ſubſtantial formes, which much give way to Monſ. *Des Cartes*'s ingenious hypotheſis, who, as his followers pretended, could ſolve all the phœnomena in nature, by his principles of matter, and motion, without the help of attraction and occult qualities. He was the firſt world-maker this Century produced, for he ſuppoſes that God at the beginning created only a certain quantity of matter, and motion, and from thence he endeavours to ſhew, how, by the neceſſary laws of *Mechaniſme*, without any extraordinary concurrence of the Divine Power, the world and all that therein is might have been produced. Nay he was ſo bold, that he pretended he could ſolve that inſuperable problem, *viz.* having a quantity of matter and motion to produce any animal. But with what confidence could he pretend to ſolve ſo intricate a problem, who blundered ſo much in the eaſieſt and moſt abſtracted things in nature, (for ſuch are the laws of motion) that of the ſeven rules he has given us about motion, there is but one of them true.

I wonder therefore why Mr. *Wotton* in his reflections on ancient and modern Learning, " ſhould ſay that *Des Cartes* joined to his " great genius an exquiſite skill in Geometry, " ſo that he wrought upon intelligible principles, in an intelligible manner, tho' he very often failed of one part of his end, namely a right explication of the Phænomena of " nature, yet by Marrying Geometry and

“ Phyſicks together, he put the World in “ hopes of a Maſculine ofspring. This I think is a clearer demonſtration than any in *Des Cartes*’s principles of Philoſophy, that Mr. *Wotton* either underſtands no Geometry, or elſe that he never read *Des Cartes*’s principles, for from the beginning to the end of them there is not one demonſtration drawn from Geometry, or indeed any demonſtration at all. Except Mr. *Wotton* will ſay, that every thing that is illuſtrated by a figure, is a demonſtration, and then indeed he may produce enough of ſuch demonſtrations in his Philoſophical works. So far was *Des Cartes* from Marrying Phyſicks with Geometry, that it was his great fault that he made no uſe at all of Geometry in Philoſophy. It may perhaps be thought that he underſtood Geometry as well as moſt of his cotemporaries, and therefore Mr. *Wotton* might have preſumed, that he ought to have joined Geometry to natural Philoſophy, but ſince he aſſerts that he actually did ſo, I think it a convincing argument that he makes himſelf a judge of things he does not underſtand. But what he falſly aſcribes to *Des Cartes*, is really true of *Galileo* and *Kepler*, who, by the help of Geometry have diſcovered Phyſical truths that are worth more than all *Des Cartes*’s Volumes of Philoſophy, who was ſo far from applying Geometry and obſervations to natural Philoſophy, that his whole Syſtem is but one continued blunder upon the account of his negligence in that point. This I can eaſily prove by ſhewing that his Theory of the *Vortices*, upon which his Syſteme is grounded, is abſolutely falſe. The great Philoſopher of this age, the moſt Ingenious and Incomparable Mr. *Newton* by his great and deep skill in Geometry, has ſhewed that the periodical times of all Bodies which ſwim in *Vortex*, muſt be directly as the ſquares of their diſtances from the center of the Vortex. But it is evident from obſervations, that the Planets in turning round the Sun, obſerve quite another ſort of a law than this, for the ſquares of their Periodical times, are always as the cubes of their diſtances, and therefore ſince they do not obſerve that law, which of neceſſity they muſt, if they ſwim in a *Vortex*, it is a demonſtration that there are no vortices, in which the Planets are carried round the Sun.

Beſides if the earth were carried in a *Vortex*, it muſt neceſſarily move faſter, when it is in the beginning of *Virgo*, where the fluid is in a narrow ſpace, (and by conſequence moves ſo much the ſwifter,) than it would do when it is in the beginning of *Piſces*, and that in the proportion of three to two, which is directly againſt experience, and obſervation.

It is impoſſible therefore upon this, and a great many other accounts, which Mr. *Newton* has ſhew'd in his principles, that the earth and the other planets can move in a *Vortex*. So that the notion of a *Vortex* being ruined, the whole *Carteſian* ſyſtem muſt of neceſſity fall to the ground; and that world, whoſe origination he pretended to have deduced from Mechanical principles, muſt be a wild chimera of his own imagination.

I cannot paſs without reflecting upon another great error in the *Carteſian* Philoſophy, which he committed purely for want of due obſervations. And that is, his reaſon why at the Moon's oppoſition, or conjunction with the Sun, the Tides ſhould be greater than at her quadratures. To explain this, he makes the Moon move round the earth, in an Ellipſis, in whoſe centre the earth is placed, ſo that by this means, the Moon will have two *Apogeons*, and two *Perigeons*, and he ſays that the Moon is in one of her *Perigeons* always at the time of her oppoſition, or conjunction, and by this means ſhe preſſes then more ſtrongly upon the Sea, than ſhe does at her quadratures, at which time according to him ſhe is always in one of her *Apogeons*, and therefore her preſſure muſt be weaker. All this is ſo notoriouſly falſe, that there is no Almanack-maker but can demonſtrate the contrary, and if he had but in the leaſt conſidered the Theory of the Moon, he might eaſily have ſeen that the Moon is as often in her *Apogeons* at new and full Moon, as ſhe is in her *Perigeons* at that time, tho' it ſeldom happens at the lunations that ſhe is exactly in either.

By this it may ſufficiently enough appear, that the moſt ingenious thoughts in the Carteſian Philoſophy, are falſe, and diſagreeable to nature, which I have ſhew'd not only becauſe the Philoſophers of that ſect have pretended to ſo very great things, as to give a true account of all the Phænomena's in nature, whilſt they underſtand ſo very little, that they have not given us a right explication of any one thing ; but alſo becauſe Mr. *Des Cartes*, the author of that Sect, was the firſt who introduced the fancy of making a World, and deducing the origination of the Univerſe from Mechanical principles. Which notion has been ſo ſtifly maintained by his admirers, that by it they have given the ignorant Atheiſts (for ſo are moſt of that perſwaſion) ſome plauſible pretences for their incredulity without any real ground.

But of all Philoſophers, thoſe have done Religion the leaſt ſervice, who have not only aſſerted, that the world was made by the laws of Mechaniſm, without the extraordinary concurrence of the Divine power; but alſo that all the great changes which have happened to it, ſuch as the Deluge, and other great effects delivered to us as miracles by the ſacred writers, were the neceſſary conſequences of natural cauſes, which they pretend to account for. Theſe contrivers of Deluges, have furniſhed the Atheiſt with an Argument, which upon their ſuppoſition is not ſo eaſily anſwer'd as their Theories are made. Which is this.

The World they will ſay, was never either made or created by God in time, but did exiſt from all eternity, without any change, or alteration, but ſuch as happened from pure Mechanical principles, and cauſes, and the true reaſon, why there remain no records; or traditions of facts done in the time beyond four or five thouſand years, is becauſe there has happened a Deluge, the memory of which is ſtill preſerved, and this Deluge being the neceſſary conſequence of natural cauſes, did ſweep away all mankind, and with them the memorials of all former ages, only a couple of ignorant country people ſome way or other, ſaved themſelves from the univerſal Cataſtrophe, and from their offſpring the earth was again repleniſhed, and arts and ſciences invented, which our forefathers before that deluge underſtood more perfectly than we do now.

This they will tell you is their hypotheſis, and they will not be beaten eaſily from it, ſince it may be defended as well, as any other Philoſophical Theory which pretends to give an account of the origination of the World, and is as precarious as their own ſyſtem of principles which they pretend is very poſſible, ſince ſeveral Philoſophers have ſhew'd various ways, how there might have happened ſo univerſal a deluge, from Mechanical principles, and the neceſſary laws of motion.

Thus we ſee how theſe flood-makers have given the Atheiſts an Argument to uphold their cauſe, which I think can only be truely anſwer'd by proving an univerſal Deluge from Mechanical cauſes altogether impoſſible. And therefore I deſign to ſhew that the moſt ingenious Theories fram'd upon that account, come far ſhort of the deſign of the Framers, and that the great and wonderful effects, which they endeavour to explain, could never have riſen from the cauſes they aſſign.

This I intend to do by ſhewing that their Theories are neither conſonant to the eſtabliſhed laws of motion, nor to the acknowledged principles of natural Philoſophy, of that Philoſophy I mean, which is founded upon obſervations and calculations, both which are undoubtedly the moſt certain principles, that a Philoſopher can build upon. It is in vain to think that a ſyſtem of Natural Philoſophy can be framed without the aſſiſtance of both, for without obſervations we can never know the appearances and force of nature, and without Geometry and Arithmetick we can never diſcover, whether the cauſes we aſſign are proportional to the effects we pretend to explain. This the various ſyſtems of the Philoſophers do evidently ſhew, which are by far more diſtant from the truth, than they are from one another. And I hope it will appear yet plainer by the following examination of Dr. *Burnet's Theory of the Earth*. Which tho' it has been publiſhed many years, and has been animadverted upon by ſeveral, yet it has not been ſo fully refuted as it might have been, nor has any one ſhew'd the greateſt miſtakes in it. Nay, Mr. *Eraſmus Warren*, who has wrote the greateſt Volum againſt it, in my opinion has ſpoken the leaſt ſenſe about it.

He begins his diſcourſe with a ſaying of an old Heathen, that Philoſophy is the greateſt gift that ever God beſtowed on man. Which I will not deny, ſince he has been at ſo much pains to make a Panegyrick on the uſefulneſs of it. But it is plain to any who will be at the pains to read his Book, that God has thought fit to beſtow but very little of that great gift upon him. And that the world may not think that this is ſaid out of ill nature and without grounds, I will give them a taſt of his Philoſophy, Geometry, or Geography, (call it which you pleaſe.) He deſigns to calculate how much colder the *Poles* would be if the earth were of an Oval figure, than if it were perfectly Spherical. To do which he ſuppoſes that a Circle formed into a moderate Oval, will have its *Poles* at leaſt a fortieth part farther diſtant from the *æquator*, than if it were perfectly ſpherical. " Now according to this proportion,

“ allowing the earth to be 7000 miles in
“ Diameter and adding a fourth part to ren-
“ der it Oval, *viz.* 1750 miles thickneſs;
“ the earth at each Pole muſt bear above
“ fourteen degrees latitude more than if it
“ had been round. So that the hypotheſis
“ which removes its Poles ſo much farther
“ from the Sun, muſt alſo allow the cold
“ thereabouts to be proportionably augment-
“ ed. *And tho' in the hundred and fourth de-*
“ *gree of latitude* (as we muſt call it,) on
“ each ſide of the *æquator*, that is, at the
“ very Poles, there might have been a per-
“ petual day, *&c.* *

This is the firſt time I ever heard that there could be more than ninety degrees between the pole and the æquator, but he thinks he has fairly made it out that there can be a hundred and four degrees between them, and therefore, there muſt be four hundred and ſixteen degrees in the whole circumference, and then, every right angle being only proportional to ninety degrees, there muſt be more than four right angles about one point, and therefore the Corollary of the 13th of the firſt of *Euclid* muſt be falſe. Thus has that ſubtle Philoſopher not only ſubverted Dr. *Burnet*'s *Theory*, but alſo *Euclid*'s demonſtrations, and that by an argument which the dull Mathematicians could never diſcover.

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* *Warren's Geology page* 116.

But I will leave *Euclid* to his mercy, and anſwer that part of his argument that concerns the *Theory*: which is eaſily done, if he will conſider that the difference between the *poles* of the earth's diſtance from the Sun, and the *æquator* of the earths diſtance from the Sun, even tho' the earth were ten times more Oval than he would have it, is ſo very inconſiderable that it does almoſt bear the ſame proportion to the whole that a point does to a line, for the Mathematicians know that the diameter of the earth is but a point, in reſpect of its diſtance from the Sun, and therefore two lines drawn from the Suns centre to any two points of it are very near in a proportion of equality, ſo that upon the account of a greater or leſſer diſtance of the parts of the earth from the Sun, there can be no ſenſible alteration of heat or cold.

But I am afraid this is a little too far beyond Mr. *Warren*'s capacity, however to ſurprize him a little more, I will tell him, he is ſo far out in his account of the cold at the *poles*, that tho' the North *pole* be much colder in the Winter than it is in the Summer, yet it is ſome hundred thouſands of miles nearer to the Sun in Winter than in Summer. If he pleaſes to conſult the Aſtronomers, they can demonſtrate the truth of this to him.

I beg Mr. *Warren*'s pardon for bringing him into this place, I ought to have been favourable to him, he being one of my Aſſociates againſt Dr. *Burnet.* But I was willing to produce him as an inſtance, to ſhew how unfit a man who underſtands no *Geometry*, is to write a book of *Natural Philoſophy.*

But to return to the *Theory*, I cannot but acknowledge, that there was never any book of Philoſophy written with a more lofty and plauſible ſtile than it is, the noble and elegant deſcriptions the Author gives the ſubject he treats of, ſhew that he has a great command of Language. His Rhetorical expreſſions may eaſily captivate any incautious reader, and make him ſwallow down for truth, what I am apt to think the Author himſelf, from the ſacred character he bears, deſigned only for a Philoſophical Romance, ſeeing that an ordinary Examination thereof, according to the laws of Mechaniſme cannot but ſhew, that he has acted the part of an Orator much better than he has done that of a Philoſopher. For in reality none of theſe wonderful effects, which he endeavours to explain, could have proceeded from the cauſes he aſſigns. And to demonſtrate this is the deſign of this ſmall Treatiſe, in which I will not inquire how far the Theory is agreeable to Holy Scriptures, that being a work already done by others, who I preſume underſtand that Subject better than I do, neither will I confine my ſelf to follow the Author from Chapter to Chapter, and find Fault with every thing contain'd in the

Theory, leaſt it ſhould look more like ſpitefulneſs and ill nature than a diligent ſearch after Truth. My deſign therefore is to choose out ſome of the principal heads of the Theory, and having ſhown them to be falſe and diſagreeable to the laws of Mechaniſme, the reſt muſt all fall to the ground of courſe.

CHAP. I.

An Examination of the Theoriſts general Argument which he uſes to prove the Truth of his Theory.

IN the ſecond and third Chapters the Theoriſt makes way for an Argument which he alledges in his ſeventh to prove the truth of his Theory, *viz.* that all other wayes for the explication of *Noah*'s *Flood* are falſe and impoſſible, and that he has given the only poſſible, and conſiſtent Idea of an univerſal flood, and therefore it came to paſs the way he has aſſigned and no other. This Argument we ſee is founded upon two Propoſitions. 1*ſt.* That no other way is poſſible, and 2*dly.* That his own Theory is an intelligible and conſiſtent explication of the univerſal flood. This laſt Propoſition I intend to examin in the following Chapter, and the firſt in this.

The Theoriſt, to prove all the common ways of explicating the univerſal deluge falſe and impoſſible, Calculates the quantity of water, which would be ſufficient to cover the whole Earth, above the Tops of the higheſt Mountains, and finds that no leſs than eight Oceans of water could be ſufficient for ſuch a Work. Now it is certain (ſays he) that ſuch a ſtock of waters could neither come from the Sea, the Rain, or ſubterraneous Caverns, and Channels of the Earth, there being no ſuch quantity of water in Nature, as would be requiſite for ſuch a Purpoſe: and therefore the explication of the deluge from theſe cauſes is impoſſible. Neither will he allow any ſupercelestial waters to make up the eight Oceans neceſſary for the deluge. For if there were any ſuch waters, the Heavens above where they lay muſt be either ſolid or fluid. If ſolid as Glaſs or Chryſtal, how could the waters get thro' them to deſcend upon the earth? If fluid as the Air or *Æther*, how could the waters reſt upon them, it being heavier than Air? But if you will ſuppoſe, that waters were brought down from this imaginary region, to drown the world, in that vaſt quantity that would be neceſſary, what became of them when the deluge ceaſed? It would be a hard task to lift ſeven or eight Oceans of water up among the ſpheres, and there is no room for them here below. Thus the Theoriſt thinks, that the vulgar opinion makes the deluge impoſſible and unintelligible upon a double account, both in requiring more water than can be found, and more, if found, than can be diſpos'd of.

This is the ſum of the Theoriſt's Argument, why all other methods and explications of the deluge are falſe, and impoſſible, which I have here related, becauſe I think it an evident demonſtration of the impoſſibility of all *Natural* and *Mechanical* explications of the deluge whatſoever, even his own not excepted, as I ſhall ſhew in its due place: it being impoſſible for Nature, not aſſiſted with extraordinary divine power, to bring ſo much water upon the earth; and if it were once brought, it is as impoſſible to remove it.

But all this does no way prove, that the deluge might not have been brought upon the earth by the Almighty power of God. Cannot he bring out the waters from the deep or the *Abyſſe* as from a Storehouſe, and ſuſtain them from running down again with the ſame eaſe he made the waters of the *Red Sea* ſtand on a heap, while the *Iſraelites* paſſed through? Is any thing of this nature too hard for the Almighty to perform? Might not he, if there were not enough in the abyſſe, bring water on the earth from the Heavens above, which might have been there from the Creation notwithſtanding the Theoriſt's queſtion, How could they reſt there? Since the ſame power might keep them in their place, that detains the Moon or any other of the Planets in their orbits; and perhaps from ſome of theſe, or from other places beſt known to the Divine wiſdom, ſome of this water was brought upon the earth, and afterwards remov'd by the Omnipotent hand of God who only worketh great wonders. Is not this a much eaſier and ſhorter account of the deluge than the Theoriſt's, which is built upon falſe and precarious principles, and inconſequential concluſions, which after all will not be ſufficient to produce the deſired effect?

But it ſeems the Theoriſt is not very willing to acknowledge that God Almighty had any hand in that great Cataſtrophe of the world, tho' it be plainly told us in Scripture that he was the immediate Author thereof, *Gen.* 6. 17. *Behold*, (ſaith God) *I, even I, do bring a flood of waters upon the earth.* Nor do I ſee any reaſon why he ought not to acknowledge the univerſal deluge of the world to be Miraculous, as well as the deſtruction of *Sodom* and *Gomorrah* was by raining of Fire and Brimſtone; ſince they were both ſent as puniſhments for the ſins of men: neither of which, without doubt, had ever happened if man had continued in the ſtate of Innocence.

The Scriptures give us an account of ſeveral Miracles wrought by the hand of Omnipotence upon occaſions, which did not ſo neceſſarily require them. Why ought we then to deny this univerſal deſtruction of the earth to be miraculous? Miracles are the great and wonderful works of God, by which he ſheweth his Dominion and Power, and that his Kingdom reacheth over all, even Nature her ſelf, and that he does not confine himſelf to the ordinary methods of acting, but can alter them according to his pleaſure. Were not they given us to convince us of the ſacred truths contained in holy Scripture? Was it not by the demonſtrative force of Miracles that *Moſes* and the Apoſtles proved their divine Miſſion, beyond all that other Framers of Religions could pretend to? And tho' our holy Faith ſtands ſo well confirmed by real miracles, that we are neither to make nor admit of any falſe ones, yet certainly we are not to detract from the value of the true ones, by pretending to deduce them from *Natural* and *Mechanical* cauſes, when they are no ways explicable by them. It is therefore both the eaſieſt and ſafeſt way, to refer the wonderful deſtruction of the old world to the Omnipotent hand of God, who can do whatſoever he pleaſes.

CHAP. II.

Of the Chaos.

THAT the Earth was formed from a *Chaos*, muſt be unqueſtionably own'd by all, who acknowledge the Holy Scriptures, for they tell us, that in the beginning *the Earth was without form and void, and darkneſs was upon the face of the deep:* which is a moſt excellent deſcription of that Chaos, from which the world aroſe. From it therefore the Theoriſt begins to frame his Antediluvian earth by the ſole help of Natural and Mechanical cauſes. He ſuppoſes the *Chaos* to be the matter of the earth and heavens, without form or regularity, reduc'd into a fluid Maſſe, wherein are the materials and ingredients of all Bodies mingled in confuſion one with another, without any order of higher or lower, heavier or lighter, ſolid or volatile. The firſt change he imagines that did happen to this Maſſe, was, that the heavieſt and groſſeſt parts ſunk down towards the middle of it (for there he ſuppoſes the Center of its gravity) and conſtituted the hard and ſoſid interior part of the earth. The reſt of the Maſſe which ſwam above, was alſo divided by the ſame principle of gravity into two orders of bodies, the one liquid like water, the other volatile like air. For the fine and active parts diſintangling themſelves by degrees from the reſt, did mount above them, and having motion enough to keep themſelves upon the wing, did play in theſe open places, where they were to conſtitute that body we call Air: the other parts being groſſer than theſe ſettled in a Maſſe together under the air, upon the body of the earth, compoſing not only water ſtrictly ſo called, but the whole Maſſe of liquors and liquid bodies belonging to the earth; of which there were two kinds, one of which is fat, oily and light, and the other lean and more earthy, like common water. Now it being well known that theſe two liquors mixed together, if left to themſelves and the general action of nature, ſeparate one from another, as in Cream and thin Milk, Oil and water, and ſuch like: So we cannot doubt but that the ſame effect would follow here, and the more oily and light parts of this Maſſe would get above the other and ſwim upon it. Thus would the whole Maſſe of liquids be divided into two leſſer Maſſes.

Now if we look over again theſe two great Maſſes of Air and Water, we cannot but imagine, that they were both at firſt very muddy and impure: for the air was yet thick, groſſe and dark, there being abundance of terreſtrial particles ſwiming in it ſtill, after the groſſeſt were ſunk down, and the leſſer and lighter, which remain'd in the Air, did ſink too, but more ſlowly. So that in their deſcent they did meet with the oily liquor upon the face of the deep, which did intangle and ſtop them from paſſing any farther, ſo as mixing there with that unctuous ſubſtance, they did compoſe a certain ſlime, or fat, ſoft earth, ſpread upon the face of the waters. And this thin and tender Orb encreaſed more and more as the little earthy particles detain'd in the air could make their way to it; and mingled with that oily liquor, till at length they ſuck'd it all up, and were wholly incorporated together: which was the firſt concretion and firm conſiſtent ſubſtance upon the face of the Chaos.

After this faſhion has the Theoriſt formed his Antediluvian habitable world, which doth not much differ from the *Carteſian* method of making the earth, only *Des Cartes* being ſomewhat wiſer than the Theoriſt, would not allow the outward cruſt, within whoſe bowels the waters were ſhut up, to be a habitable earth, knowing well that neither man nor beaſt could live long without water. But he made the cruſt firſt broken, and the waters flow out, before he plac'd any inhabitants on it. Another ſmall difference betwixt the two hypotheſes, is, that *Monſ. Des Cartes* never thought of making the exterior Orb of oily liquids, which the Theoriſt aſſerts to be abſolutely neceſſary towards the formation of the cruſt. For if it were not, ſays he, for the oily liquor which ſwims upon the ſurface of the Abyſs, the particles of earth which fell thro' the air had ſunk to the bottom, and had never formed the exterior Orb of earth.

But notwithſtanding this, I believe it may be eaſily made evident (tho' neither of their Syſtems are true) that the Theoriſt's hypotheſis is the worſt of the two. Which I will prove from his own conceſſions: for he has already own'd that the oily liquor is much lighter than the watery Orb. He has mentioned alſo that the terreſtrial particles when falling from the air, if the Orb were only water, would ſink to the bottom; and therefore thoſe particles muſt be heavier than water. From thence, I think, it does neceſſarily follow, that thoſe terreſtrial particles muſt alſo be heavier than the oily fluid which is lighter than water, and therefore they will more eaſily deſcend thro' it than they did thro' water, it being well known that there are ſeveral bodies which will ſwim in water, but ſink in oil.

But that which ſeems to have deceiv'd the Theoriſt in this point was, that he had obſerved that ſmall duſt, tho' ſpecifically heavier than oil, yet being thrown upon it, it did not ſink, and therefore he concluded, that a great deal of it, if caſt upon the Surface of oil, after the ſame manner, would not deſcend, but form a ſolid concrete ſubſtance upon the ſurface of the oil. But this conſequence will ſoon appear to be falſe, if we conſider the true reaſon why ſome bodies, tho' ſpecifically heavier than the fluid in which they are put, do not ſink, but ſwim upon the ſurface: which is this; That there is ſcarce any liquid in nature which is abſolutely fluid, and whoſe parts do not reſiſt ſeparation one from another, and therefore will ſomewhat hinder or retard the deſcent of bodies thro' them. Now this reſiſtance (all other things being alike) is always proportional to the ſurface of the body deſcending: ſo that ſmall bodies, whoſe weight or force to move or ſeparate the parts of the fluid, is but very little, may have a ſurface ſo large, that they cannot overcome the reſiſtance of the fluid; that is, they cannot make way for their deſcent thro' the fluid, and therefore muſt ſwim upon the ſurface of it: but the ſurfaces of bodies not increaſing in the ſame proportion with their ſolidities or weights, ſmall bodies will have a greater reſiſtance in proportion to their weight, than greater ones of the ſame intenſive gravity, and conſequently the one will deſcend when the other cannot. As for example, ſuppoſe a ſphere of an inch diameter was put into an oily fluid, whoſe reſiſtance was juſt equal to the force of gravity in the deſcending body: there being an æquilibrium, the former would ſwim in the latter. Now if another ſphere of two inches diameter, and of the ſame intenſive gravity were put in the ſame fluid, its gravity or force by which it would ſeparate the particles of the fluid, would be eight times greater than the deſcending force of the former ſphere; and if its reſiſtance were alſo eight times greater, it is plain that it alſo could not deſcend: but the reſiſtance being always (as I noted before) as the ſurface of the deſcending body, is only in the preſent caſe four times greater; which will not equal the force of its gravity, and therefore the ſphere muſt deſcend. So in our preſent caſe, tho' ſome ſmall grains of duſt or earth may ſwim upon the ſurface of Oil, yet theſe when increas'd by the addition of a great many others which fall upon them, augment their weight (the ſame reſiſtance continuing) and muſt fall to the bottom.

Beſides this, the earthy particles falling from a great height, ſome of them deſcending from places as high as the Moon, as the Theoriſt will have them, muſt needs in their deſcent acquire a very conſiderable degree of velocity, with which falling upon the ſurface of the oily Orb, they will not only by that force deſcend themſelves, but alſo carry down with them, and condenſe whatſoever bodies they met in their way or found ſwimming upon the ſurface of the oil. Now that the force of a deſcending body is ſo great as to perform this effect, I think, is clear to any who conſiders that a heavy body runs down fifteen foot in a ſecond, and that the ſpaces thro' which it does move, are always in a duplicate proportion to its times, as is demonſtrated by *Galileo*, and confirmed by the Experiments of *Riccioli:* from whence by calculation it will follow that a body would run down four thouſand miles in the ſpace of twenty three ſeconds, abſtracting from the reſiſtance of the air. But if we will ſuppoſe but the hundredth part of this ſpace run thro' in that time, allowing all the reſt for the reſiſtance of the Medium, yet even in that caſe, the velocity would far exceed that of the ſwifteſt bullet, that can be ſhot out of a Cannon.

Thus, I think, I have made it evident, that the particles of earth after falling thro' the air, could not reſt upon the ſurface of the oily Orb, to form there an hardened habitable Cruſt, not only upon the account of their greater gravity, which the Theoriſt acknowledges, and is alſo plain by experience, common earth being near twice as heavy as water; but alſo upon the account of the great force by which they muſt of neceſſity fall upon the liquid Orb, which will carry them down towards the Center.

I hope now it will appear to any thinking man, plainly impoſſible, that either oil or water ſhould ſuſtain ſuch an immenſe heavy Orb, in which was not only the ſoft earth, which in few places is ten foot deep, but alſo a prodigious quantity of ſtones and minerals much heavier than water: for it is certain that theſe great heavy bodies muſt have ſunk to the bottom if they were left to themſelves, and yet even theſe bodies make up the greateſt part of our outward earth. I know the Theoriſt does boldly affirm, that there was neither Metals nor Minerals in the primitive earth; but this is both contrary to reaſon and Scripture, for the Holy Scriptures tell us, that *Tubal Cain* before the floud, was an inſtructer of every Artificer in Braſs and Iron: and I would fain know, how there could be ſuch Artificers before the floud, when, according to him, there was no ſuch thing to be ſeen as Metals. Beſides, 'tis hardly poſſible to build an Ark, that ſhould contain all the terreſtrial and aerial animals, without Iron. The *Americans* without any Iron made themſelves ſmall Cannoes of one ſolid piece of Timber which they hollowed by burning, but it would be a ſtrange Tree that was of the dimenſions of the Ark, and could contain ſo many animals as it did. Theſe things do (in my judgment) plainly ſhow, that the Theoriſt's opinion in this point is utterly falſe.

From what I have already ſaid, I think, it may be clearly demonſtrated, that the Fabrick of the earth can never be deduced from a

Chaos, by the ſole help of Mechanical principles and Natural cauſes. For it is evident to any one who has eyes (tho' there have been ſome wiſe Philoſophers of another opinion) that the Land is higher than the Water; and it is alſo plainly experienced, that common arable earth or clay is much heavier than water: and if we deſcend into the Mines or Pits, we ſhall find the matter there to be three or four times heavier than the earth above. Now it is plain from what I have already proved, that in a Chaos, the true change that would follow from Mechanical principles and Natural cauſes, is, that if all were fluid, the heavieſt and ſolideſt Bodies would ſubſide and fall to the Center, every one taking place according to the ſpecifick gravity; ſo that the lighter Bodies would always be forced uppermoſt: the earth therefore being heavier than the water, muſt of neceſſity place it ſelf nigher the Center, and leave the water to cover the face of the whole Orb. Thus the ſurface of the World could never be inhabited by any other Animal than Fiſhes. But in how much wiſer order than this, has the great Creator of the World placed all the Bodies of the earth, ſo that notwithſtanding the greater gravity of the Land, it is raiſed higher than the Sea, and thereby made fit and habitable both for man and beaſts, without the help of Natural and Mechanical cauſes, which would have produc'd the contrary effect.

Several other arguments might be brought to demonſtrate that the frame of this World was the reſult of wiſdom and counſel, and not of the neceſſary and eſſential Laws of motion and gravitation, which could never have either made or ſupported the World. I always wonder'd at the wild an extravagant fancy of the Philoſophers, who thought that brute and ſtupid matter would by it ſelf, without ſome ſupreme and intelligent director, fall into a regular and beautiful ſtructure, whoſe parts ſhould be ſo extreamly well adapted to various uſes, as if they had been the reſult of wiſdom and contrivance. I will conclude this Chapter with a diſcourſe of the Theoriſt in his 10th Chap. lib. 2.

" In the conſtruction of the Body of an
" Animal, (ſays he) there is more of thought
" and contrivance, more of exquiſite inventi-
" on, and fit diſpoſitions of parts, than is in
" all the Temples, Palaces, Ships, Theaters, or
" any other pieces of Architecture the World
" ever yet ſaw, and not architecture only,
" but all other Mechaniſm whatſoever, En-
" gines, Clock-work, or any other is not
" comparable to the Body of a living crea-
" ture. Seeing then we acknowledge theſe
" artificial works whereſoever we meet with
" them, to be the effects of wit, under-
" ſtanding and reaſon; is it not manifeſt
" partiality or ſtupidity rather, to deny the
" works of nature, which excel theſe in all
degrees,

“ degrees, to proceed from an intelligent
“ principle? Let them take any piece of hu-
“ man art, or any Machine fram’d by the
“ wit of man, and compare it with the Body
“ of an Animal, either for diverſity and mul-
“ tiplicity of workmanſhip, or curioſity in
“ the Minute parts, or juſt connexion and
“ dependance of one thing upon another, or
“ fit ſubſerviency to the ends propos’d of Life,
“ Motion, Uſe, and Ornament to the creature:
“ and if in all theſe reſpects, they find it ſu-
“ perior to any work of human production,
“ as they certainly muſt, why ſhould it be
“ thought to proceed from inferior and ſenſe-
“ leſs cauſes? ought we not in this as well
“ as in other reſpects to proportion the cauſes
“ to the effect, and to ſpeak truth, and bring
“ an honeſt verdict for Nature as well as for
“ Art?

I deſire the Theoriſt may apply this excellent diſcourſe to himſelf, and conſider whether this Argument which he produces againſt the *Epicureans* and Atheiſts, does not fully ſhew the abſurdity of his own Theory.

CHAP. III.

Of the Mountains.

THE Theoriſt frames his *Antediluvian* Earth, ſmooth, regular and uniform, without Mountains, and without a Sea. The proof which he brings for this bold aſſertion, is, that the Globe of the Earth could not riſe immediately from a Chaos into the irregular form, in which it is at preſent; the Chaos, ſays he, being a fluid Maſſe, which we know does neceſſarily fall into a ſpherical ſurface, whoſe parts are *equidiſtant* from the Centre, in an equal and even convexity one with another. And ſince upon the diſtinction of the Chaos, and ſeparation into ſeveral elementary maſſes, the Water would naturally have a ſuperior place to the Earth, 'tis manifeſt there could be no habitable Earth form'd out of the Chaos unleſs by ſome concretion upon the face of the Water. Then laſtly ſeeing this concrete Orb of Earth upon the face of the Water would be of the ſame form with the ſurface of the Water it was ſpread upon, there being no cauſes that we know of, to make an inequality in it, we muſt conclude it equal and uniform, and without Mountains, as alſo without a Sea. For the Sea and all the Maſſe of Water was inclos'd within this exterior Earth, which had no other baſis or foundation to reſt upon.

This is the Theoriſt's great argument why the face of the primitive earth was ſmooth and uniform and without Mountains; which if we conſider narrowly, it will apear to depend upon a precarious and falſe ſuppoſition, namely that the great Maſſe of matter which we have now for our earth, was, when in a Chaos, an entirely fluid Maſſe, which is a hard thing to be granted, ſince the greateſt parts of Bodys we have in the earth, at leaſt ſo far as we can diſcern, are hard and ſolid, and there is not ſuch a quantity of water in the earth, as would be requiſite to ſoften and liquify them all. Beſides, a great part of them, as Stones and Metals, are uncapable of being liquified by water. We muſt conclude therefore that the Chaos was not ſo fluid a Maſſe, as would be neceſſary for to have its ſurface even and uniform. Why might not there have been in this great Maſſe huge lumps of firm and ſolid matter, which without any form, order, or regularity, might be jumbled together, and ſwimming up and down, ſome on the ſurface, and ſome within the fluid? I will leave it to any to judge which appears moſt like a Chaos, this which I have deſcrib'd, or his, which is a regular, uniform fluid of a ſpherical figure, ſo compoſed and mix'd with all Bodies that no part of it, at leaſt at the ſame diſtance from the Centre, is thicker than another: which muſt neceſſarily fall out, if the Chaos had an exact ſpherical figure, as the Theoriſt ſuppoſes. If it were otherwiſe, it is plain by *Hydroſtatical* Principles, that there the fluid would riſe higheſt, where it is thinneſt, or lighteſt; and conſequently it would not have its ſurface uniform, equally even and diſtant from the Centre.

Indeed, methinks the Theoriſt's firſt figure of the Chaos, does very much contradict his own hypotheſis. There you may ſee repreſented great pieces of hard and ſolid matter of no regular figure, ſwimming confuſedly in the fluid; any one of which ſeems to bear a far greater proportion, to the whole Maſſe; than the higheſt hills could do to the whole Earth.

But perhaps it may be ſaid that all theſe hard and ſolid Bodies being heavier than the fluid in which they ſwam, fell down and compos'd the Central ſolid. And ſo far I muſt own indeed, that all the Bodies in that great Maſſe, which were heavier than water, if left to the laws of gravity, would neceſſarily fall down toward the Centre. But certain it is that in ſuch a great heap of matter, and ſo different mixtures of all ſorts,

Mollia cum duris, ſine pondere habentia pondus.

there muſt be ſeveral that were ſpecifically lighter than the water in which they ſwam, and therefore after that the heavieſt had fallen to the Centre, they would ſtill float upon the ſurface, ſo much of them being under water as would equal in quantity a bulk of water of the ſame gravity with the whole Maſſe, as it is demonſtrated by *Archimedes* 5. *Propoſition. Lib.* 1. *De Inſidentibus Humido*; ſo that all the reſt of the Maſſe ſtanding out or being higher than the fluid would compoſe a Mountain. And that hills may be thus made, I think is confirmed by the obſervation of thoſe who have failed in the *Northern* Seas, where they ſee great Mountains of Ice floating upon the top of the waters, and yet there is but a very ſmall difference between the ſpecifick gravity of water and Ice, it being as eight to ſeven according to Mr. *Boyle's* obſervations. If then we will ſuppoſe all Mountains hollow and full of Caverns, there being a great many to our certain knowledge that are ſo, or elſe joined to ſome light matter, ſo that the whole compoſition may be lighter than water or the fluid Chaos; this would neceſſarily produce Mountains.

And now I hope the Theoriſt will own that the evenneſs and uniformity of the earth is not ſo neceſſary a conſequence from its production out of a Chaos, as he at firſt imagined, ſince I have ſhewed him how mountains might have been form'd from his own principles of *Staticks* and *Gravitation.* Yet I am of the opinion that there were other principles concurring to the formation of the world, beſides *gravitation* and the known laws of motion, which I think it left to themſelves would never produce any tolerable or habitable world.

But ſuppoſing the efficient cauſe of Mountains unknown or impoſſible to be aſſigned; yet ſtill there remains the final cauſe to be enquired into, which will do as well for our purpoſe. For if I prove them to be as uſeful to the inhabitants of the primitive earth, as they are now to us, and that in our preſent ſtate they are abſolutely neceſſary, not only for our well being, but alſo for our bare ſubſiſtance; I think from thence it will demonſtratively follow that they were in the primitive earth as well as in ours. And therefore the groundleſs aſſertion of the Theoriſt that the face of the *Antediluvian* earth was ſmooth regular and uniform, is as falſe as 'tis bold and daring.

I know there is a ſort of men in this age who have excluded all final cauſes from the conſideration of a Philoſopher, as being unworthy of his enquiry, ſuppoſing his buſineſs is only to find out the true formal and efficient cauſes of all things, and not to concern himſelf with the deſign of nature, or the great end for which the God of Nature made any thing. But indeed theſe men have been ſo unhappy in their ſearches, that I dare boldly ſay they have not ſo much as diſcovered the true, real and efficient cauſe of any one of the Phænomena which was not known and better explain'd before; tho' they have pretended to lay open the *eſſences* and *formal cauſes* of all things, and to ſhew the manner, how the Univerſe was formed from the principles of Matter and Motion.

But whatever they pretend, certain it is, that final cauſes are worthy of the conſideration of all men, and much more of a Philoſopher. By them we are led into the admiration of the wiſdom of God, and diſcover his care and providence over the world; By them we demonſtrate that the World could never be made by chance; but it muſt be a being of infinite wiſdom that form'd it for ſuch various uſes as are to be ſeen in it. And therefore by all wiſe and conſidering men they are much more to be valued than efficient cauſes, if they could be diſcovered; which only tell us how the thing was perform'd, and not the uſe for which it was deſign'd. 'Tis true indeed, it is not eaſy to diſcover the uſe of every thing in the Univerſe; but from the admirable contrivance of thoſe things, the uſes of which we do know, and from the infinite wiſdom of God, it may be eaſily concluded, that every thing in nature has its uſe, and is in ſome manner ſerviceable to the good of the whole.

They who deſire to ſee more concerning the uſefulneſs of final cauſes, may conſult Mr. *Boyle* of final cauſes, Mr. *Ray's* wiſdom of God in the works of the Creation, and ſome late ingenious eſſays upon the nature and evidence of faith by Dr. *Cockburn.*

I muſt confeſs I cannot but think it a ſtrange and preſuming boldneſs in the Theoriſt to aſſert, that Mountains are plac'd in no order one with another, that can either reſpect uſe or beauty: and that if they are ſingly conſider'd they do not conſiſt of any proportion of parts, that is referable to any deſign, or hath the leaſt footſteps of art or counſel. Notwithſtanding this ſtrange aſſertion, I am ſure, if we were without theſe ſhapeleſs and ill figur'd old Rocks and Mountains, as he calls them, we ſhould ſoon find the want of them. It being impoſſible to ſubſiſt or live without them.

For ſetting aſide the uſe they may have in the production of various Plants and Metals, which are uſefull to mankind, and make a part of the compleat whole, and the Food which they yield to ſeveral Animals, which are deſign'd by Nature to live upon them; *The high Hills being a refuge for the wild Goats, and the Rocks for the Conies*; and not to mention the end they ſerve for in directing the Inland winds, and altering the weather, in fencing and bounding Empires and Countries, in all which without doubt they do us very conſiderable ſervice; there is moreover one great and Univerſal uſe, which makes them abſolutely neceſſary for the ſubſiſtance of Mankind. For without them it is certain we ſhould have no Rivers, nor freſh currents of waters, and conſequently we ſhould want one of the greateſt ſupports of Life. This the Learned and Ingenious Mathematician and Philoſopher Mr. *Edmund Halley* has effectually proved in the *Philoſophical Tranſactions*, where he gives us an account of the riſe of Springs and Rivers from Vapours, * " That are raiſed " copiouſly in the Sea, and by the winds are " carried over the low Land to the high " ridges of Mountains, where they are compelled by the ſtream of the air to mount up " with it to the tops of the Mountains, where " they preſently precipitate, gleeting down " by the cranies of the ſtones, and part of " the Vapour entring into the Caverns of " thoſe Hills, the waters thereof gather as in " an Alembick, into the baſons of ſtone it " finds; which being once filled, all the " overplus of water that comes thither, runs " over by the loweſt place and breaking out " by the ſides of the Hills, forms ſingle " Springs, many of theſe running down by " the *valleys* or *gutts* between the ridges of " the hills, and coming to unite, form little " rivulets or brooks, many of theſe again " meeting in one common valley and gain-

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* *Philoſophical Tranſactions Number* 192.

" ing the plain ground being grown leſs
" rapid become a River, and many of theſe
" being united in one common channel
" make ſuch ſtreames as the *Rhine*, the
" *Rhone*, and the *Danube*, which laſt one
" would hardly think the collection of waters
" condenſed out of vapours, unleſs we conſider
" how vaſt a tract of ground that
" River drains, and that it is the ſumm of
" all thoſe Springs which break out upon the
" South ſide of the *Carpathian* Mountains,
" and on the *North* ſide of the immenſe
" ridge of the *Alpes*, which is one continued
" chain of Mountains from *Switzerland* to
" the black Sea, ſo that it may almoſt paſs
" for a rule, that the magnitude of a River or
" the quantity of water, which it evacuates,
" is proportional to the length and height of
" the ridges from whence its fountain ariſes.

All this I take to be undeniably evident. For that vapours are raiſed by the heat of the Sun from the Sea in ſuch vaſt quantities as will be ſufficient to ſerve all the Rivers, the ſame ingenious Mr. *Halley* has demonſtrated by Calculations. But it is alſo demonſtrable that theſe vapours being of the ſame ſpecifick gravity with the air in which they ſwim, muſt follow its motion, that is, they muſt be carried by the winds over land untill they meet with ſuch an obſtacle as a hill in their way which reſiſts their motion, where they muſt precipitate and gleet down by its ſide and ſo form Rivers and Springs. All this is not only clear from reaſon, but is alſo confirmed by the experience of the ſame Mr. *Halley* while he was at *St. Helena* as he tells you, in the *Philoſophical Tranſactions.*

And now methinks 'tis plain, that hills are ſo very far from being placed in the earth without any art or contrivance, that they demonſtrate to us the admirable wiſdom of their great maker, who has thus formed them for ſo neceſſary ends. If the earth were ſmooth, regular and uniform; water without doubt would ſtagnate and ſtink, for how is it poſſible for water to run where there is no riſing ground, *no upper* land from which it is to deſcend to the lower and *even parts* of the earth.

I know the Theoriſt thinks, that he has clearly ſolved that great difficulty by the oval figure of his *Antediluvian* earth, in which he fancies that Rivers will run notwithſtanding the earths regular and even ſurface. But when I come to diſcuſs that point I will ſhew that the earth has not, nor ever had any ſuch oval figure as he ſuppoſes, and upon ſuppoſition it had, yet even in that caſe there could be no current Water or Rivers; and where there is no current waters there muſt be but uncomfortable living. How many great parts of the world lie perfectly deſtitute of inhabitants for want of waters? Travellers tell us fearful ſtories of the incredible *extremities* they have ſuffered in going thorough the Deſarts of *Arabia* for want of freſh waters.

It is plain therefore, that if the primitive earth was inhabitable there muſt be Mountains in it, for I think I have already proved that in a ſmooth regular earth there could be no Rivers. And the great advantages, which Countries reap by being well furniſhed with Rivers, is very evident; for without them there could be no great Towns, nor any converſe with far inland Countries; ſince without them it is almoſt impoſſible to ſupply a vaſt multitude of People with things neceſſary for life. If we ſhould ſuppoſe the *Thames* taken away from *London*, or it's courſe diverted ſo as to be at a great diſtance from it; there is no doubt but that City would quickly to *its loſs*, very much find the want of ſo great an advantage; and from being one of the greateſt in the ſpace of ſome few hundred years, it would come to be one of the leaſt Cities of the Univerſe.

It cannot be ſaid, though Rivers are now in the preſent ſtate of the world of great uſe and benefit to mankind, that in the *antediluvian* earth there was no ſuch neceſſity for them, there being no ſuch great traffick as now, nor ſuch a number of people to be maintain'd by it. For this ſeeming objection is clearly ſolved by the Theoriſt himſelf in his third Chapter Book I. where he proves the number of the *antediluvian* people to have been at leaſt as great as they are now; and the world altogether as well peopled. And if ſo, ſince men lived then to a very great age, (ſome of them to nine hundred years) they would be well taught by experience, and underſtand moſt of thoſe things which are uſeful and profitable for them, as well as we do now. But I need not go about to prove there were *Antediluvian* Rivers, ſince it is plainly aſſerted by *Moſes* that there were ſuch in the ſecond Chapter of *Geneſis*, whoſe authority I hope the Theoriſt will not deny. For he himſelf acknowledges their exiſtence before the Floud, and endeavours to explain their riſe without the help of mountains; which *explication* in its due place I will prove to be falſe and impoſſible.

Since therefore it is plain from Reaſon, from Scripture, and the Theoriſt's own conceſſions, that there were Rivers in the primitive Earth, and ſeeing it is impoſſible for any ſuch to be without Mountains, without higher and lower grounds (the Theoriſt's *Oval-figured* earth not being ſufficient for ſuch an effect) From thence it does evidently follow, that Mountains were before the floud. And therefore his aſſertion that the primitive earth was ſmooth, regular and uniform, is falſe and abſurd.

CHAP. IV.

Of the Perpendicular poſition of the Axis *of the Earth to the plane of the* Ecliptick.

AMong other Characters of the Golden Age with which the Theoriſt *endows* his primitive Earth, one is a perpetual Spring which was then all the world over, all the parts of the years being of one and the ſame tenour, face, and temper. Then, ſays he, there was no Winter nor Summer, Seed time or Harveſt, but a continual temperature of the Air and Verdure of the Earth. The reaſon which he brings for this aſſertion is, that at firſt the *Axis* of the Earth was parallel to the *Axis* of the *Ecliptick*, and conſequently the plane of the *Æquator* being coincident with the plane of the *Ecliptick*, the Sun in its diurnal motion would ſeem to move always in the *Æquator*, making equal Days and Nights throughout the year.

Notwithſtanding this fine deſcription of the Theoriſt's, I hope to make it appear in this Chapter, that the right poſition of the Earth (as he calls it) is ſo very far from being deſirable as he imagins it is, that it is one of the worſt it could have, and that therefore the Earth was never placed by God Almighty at the beginning of the world in ſuch a poſition. For I here lay it down as an *axiom* which I am confident the Theoriſt will allow, that God at the beginning placed the Earth in ſuch a poſition as was moſt advantageous to the whole, and tho' perhaps another poſition might have been fitter for ſome particular place, yet the whole would have been the worſe for it: God by his infinite wiſdom and goodneſs always chooſing ſuch conſtitutions and poſitions of things as bring with them the greateſt good and utility to the Univerſe.

Let us therefore conſider whether this right poſition, which the Theoriſt ſays was that of the primitive Earth, was the beſt it could have, and if after examination we find that no ſuch Character as that of beſt belonged to it, but rather the contrary, it being by far more diſadvantageous to the Earth than the preſent one, we may confidently conclude from the above mentioned *axiom* that the Earth never had any ſuch poſition.

That great and learned Aſtronomer *Kepler*, who certainly had more than an ordinary penetration (nay perhaps a divine impulſe) in diſcovering the works of Nature and Providence in his *Epitome Aſtronomiæ Copernicanæ*, has ſhewed that the preſent poſition of the earths *Axis* is by far preferable to any other, eſpecially to that of the perpendicular poſition to the plane of the *Ecliptick*, for he tells us in his *Lib.* 3. *Part* 4. That if the *Axis* of the earth about which it turned ſtood at right angles, with the plane of the *Ecliptick*, and the earth in the mean time turned round the Sun as it does now, that then indeed the Sun would ſeem to riſe and ſet every day, and make its circuit from *Weſt* to *Eaſt*, under the fixed ſtars in the ſpace of a year, but then there would be no diviſion of the *Ecliptick* into halves, quarters, and ſigns, no diſtinction of the year by its different qualities of heat and cold, every night would be equal to every day, there would be two places in the Earth to whoſe inhabitants more than half the Sun could never appear, but its Centre would continually turn round in their *Horizons*, never riſing higher nor falling lower, the nearer one came to the *æquator*, ſo much higher would he have the Sun in his *meridian*, but in the ſame place it would always be at a conſtant height at twelve of the Clock. In the *æquator*, the Sun throughout the whole year would alwayes be *vertical* when it comes to the *meridian*, and there only, would there be an intenſe and perpetual Summer, when at the *poles*, and in places near them, there would be an eternal Winter without any intermiſſion of Froſt and Snow. The Sun alſo would always Riſe and Set in the ſame points of their *Horizons*, and therefore,

fore, there would be no alteration in the Earth, but upon the account of day and night, and no ſort of changes in the year which would always keep the ſame tenour and face, the annual motion of the earth being of no uſe.

Theſe are the effects which the Learned *Kepler* has ſhewed, would neceſſarily follow from the poſition of the Earths *axis*, which beſides, that it makes the Earths Annual circuit round the Sun of no ſort of uſe and advantage to it, (And this I ſuppoſe cannot well agree with the infinite wiſdom of its Maker,) it brings with it ſuch a train of conſequences, which if men would conſider, I believe there would be few ſo fond of changes, as to be willing to have the preſent oblique poſition altered for the perpendicular one of the Theoriſt, which would render this whole Iſland no better than a wilderneſs, and the greateſt part of the Earth not habitable.

For under the *Æquinoctial*, to whoſe inhabitants, the Sun would continually at twelve of the Clock, ſhine perdendicularly and even throughout the *Torrid Zone*, there would be an intolerable ſcorching heat; In the *Frigid Zones* the cold could not be endured, and the greateſt part of the two temperate *Zones* would not have a ſufficient quantity of heat to ripen their fruits. All men in *England* are ſenſible that the heat we have in Summer, is but juſt great enough to bring our Corn and Fruits to perfection, and therefore if the heat we have in Summer, were no greater than it is now about the 10*th* of *March*, or the 11*th* of *September*, the Ground would not be able to produce any *vegetables* to ſupply us with food, ſo that all of us muſt have changed our Climate for ſome more fertile Soil, which receives more of the Suns influence.

This may ſerve to ſhew how vain and falſe the Theoriſt's aſſertion is, that the primitive earth had its *axis* perpendicular to the plane of the *ecliptick*, and that this poſition is ſo far from being the beſt it could have, that it may be juſtly reckoned among the worſe ſort of poſitions. I come now to ſhew the great advantages we reap by the preſent poſition of the Earth, and how apt it is to ſerve the ends for which it was deſigned by its wiſe contriver.

Kepler in the above mentioned book tells us, that the earth was deſigned a place for thoſe things which are liable to Generation and Corruption, and therefore it was by no means fit that the Sun ſhould ſhine upon every part of it throughout the year with an equal tenour and force, but there ought to be ſuch alterations and changes of his heat as are neceſſary to produce the deſign'd effects, for it is plain that different degrees of heat are requir'd for the production and ripening of moſt Plants, the heat that is requiſite for the firſt growth of a vegetable, not being ſufficient for the ripening and perfecting the ſeed thereof, and that degree of heat which is neceſſary for bringing the ſeed to perfection, would quite wither the green and tender herb.

Now all this is obtained by the preſent poſition of the Earth, and the inclination of its *Axis*, to the plane of the *Ecliptick*, for from thence ariſes the variety of Seaſons, and different degrees of heat and cold. We perceive in the Spring time, that we have the heat of the Sun ſtill increaſing in ſuch a meaſure, as the Plants require for their nutrition and growth. At laſt the Sun arrives at his greateſt *meridian* height, and then the Plants bring forth their Seeds which grow every day more and more perfect and then are fully ripe and fit for food, and when the Sun has performed his work in our part of the World, he returns again to the tropick of *Capricorne*, to make room for the Snow and Ice which comes in the Winter for the moiſtening and preparing the earth for a new Crop. And tho in the *Torrid Zone*, they never have any Snow or Ice, yet at the time of the year when the Sun is *vertical* to them, there falls ſuch a quantity of rain, as not only cools the Air, and makes the Heat of the Sun tolerable, but alſo fattens the ground and prepares it for the production of fruits.

But there is one more conſiderable advantage which we reap by the preſent poſition of the earth which I will here inſert: becauſe I do not know that 'tis taken notice of by any. And it is, that by the preſent inclination of the earth *axis* to the plane of the *ecliptick*, we who live beyond forty five degrees of Latitude, have more of the Suns heat throughout the year than if the Sun ſhined always in the *equator*, that is, if we take the ſumm of the Suns actions upon us both in Summer and Winter, they are greater than its heat would be if it moved always in the *equator*, or which is the ſame thing, the aggregate of the Suns heat upon us while it deſcribes any two oppoſite parallels, is greater than it would be if in theſe two days it deſcribed the *equator*, whereas in the *Torrid Zone*, and even in the temperate almoſt as far as forty five degrees of Latitude, the ſumm of the Suns heat in Summer and Winter is leſs than what it would be, were the *axis* of the Earth perpendicular to the plane of the *ecliptick*.

I know Dr. *Bently* in his laſt Lecture for the *Confutation of Atheiſm*, aſſerts that tho the *axis* had been perpendicular, yet take the whole year about, we ſhould have had the ſame meaſure of heat we have now. But I am not ſurpriſed to find an error of this nature aſſerted by one who as it appears is not very well skilled in *Aſtronomy*; for, in the ſame Lecture, he confidently ſays, that *'tis* *matter of fact and experience, that the Moon alwaies ſhews the ſame Face to us, not once wheeling about her own Centre,* whereas 'tis evident to any one who thinks, that the Moon ſhews the ſame face to us for this very reaſon, becauſe ſhe does turn once, in the time of her period, about her own Centre. But it were to be wiſhed, that great Criticks would confine their Labours to their Lexicons, and not venture to gueſs in thoſe parts of Learning which are capable of demonſtration, for this is our preſent caſe, and I undertake to ſhew, that we who live in this part of the World, and have greateſt need of the Suns heat, have more of it take the whole year about, than if the Sun moved continually in the *equator*, whereas they that live in the *Torrid Zone* and in places near them, and who are rather too much expoſed to the heat of the Sun, than too little, have by this means leſs of his heat than they would have, had the earth obſerved a right poſition.

I think this conſideration cannot but lead us into a tranſcendent admiration of the divine wiſdom, which has placed the earth in ſuch a poſture, as brings with it ſeveral conveniences beyond what we can eaſily diſcover without ſtudy and application, and I make no queſtion, but if the reſt of the works of nature were well obſerved, we ſhould find ſeveral advantages which accrue to us by their preſent conſtitution, which are far beyond the uſes of them that are yet diſcovered, by which it will plainly appear that God hath choſen better for us than we could have done for our ſelves, but to return to our aſſertion which I deſign to prove by the Canon invented by that excellent *Geometer* Mr. *Edmund Halley* in the *Phil. Tranſ. Numb.* 203. viz. *That the Sum of the Sines of the Suns Meridian Altitudes in any two oppoſite parallels, being multiplied into the Sine of the ſemidiurnal Arch, and thereunto adding in Summer, or ſubſtracting in Winter, the product of the length of the ſemidiurnal Arch, (taken according to* Van Ceulen's *Numbers) into the difference of the above ſaid Sines of Meridian Altitudes: the Sum in one caſe, and difference in the other, ſhall be as the Aggregate of all the Sines of the Suns Altitude, during his appearance above the Horizon in the propoſed day.* Thus that I may uſe Mr. *Halley*'s own example. Let the Solſtitial Heat in ♋ and ♑ be required at *London*, *Lat.* 51°. 3'2.

38° - 2'8	*Co-Lat.*	
23 - 30	*Decl.* ☉	
61 - 58	*Sinus* =	,882674
14 - 58	*Sinus* =	,258257
	Summa	1,140931
	Diff.	,624417

Diff. Aſcen.	33° - 11.
Arc. Semidi. æſtiv.	123 - 11,

Arc. Semidi. hyb.	56 - 49. *Sin.* ‘638923
Arc. æſtiv. menſura	2,149955.
Arc. hyber. menſura	991683.

Then 1,140931 in ,836923 + ‘624417 in 2,149955 = 2,29734 And 1,140931 in ,886929 — ,624417 in ,991638 = 33895 So that the Suns action will be as 2,29734 in the day of the Summer Solſtice, and as 0,33895 *in the Day of the Winter Solſtice.*

Acording to this Canon I have computed the Heat of the Sun for every five degrees of its declination both *North* and *South*, at the Latitude of 51 degrees as in the following Table,

The Suns Declin.	☉ Heat in North Declination.	☉ Heat in South Declination.
0	1,25864	1,25864
5	1,47393	1,04839
10	1,692937	,845079
15	1,91489	,65091
20	2,13919	,46916
23½	2,2991	,37980

By which it will appear that the heat of the Sun in the Latitude of 51 degrees while it deſcribes by its diurnal motion any two oppoſite parallels, is greater than if the Sun theſe two days had deſcribed the *æquator*, as for example, the heat of the Sun in the 20*th* degree of *North* declination is as 2, 13919 and in the 20*th* degree of *South* declination as ,46916 which two added together make, 2, 60135 which is more than double the number 1, 25864 which repreſents the heat in one *equinoctial* day, and ſo in all the reſt of the parallels. After the ſame manner the action of the Sun in Summer and Winter may be eaſily Calculated for any Latitude or diſtance from the æquator, by which it will plainly appear that the heat of the Sun while it moves from *Aries* to *Libra*, that is during the time it runs through the ſix *Northern* ſigns together with its heat while it moves from *Libra* to *Aries* again, in the ſix *Southern* ſigns, is greater to us who live beyond the 45*th* degree of Latitude, and conſequently ſtand moſt in need of the Suns heat, than it would be had the *axis* of the earth ſtood at right angles with the plane of the *ecliptick*, by which the Sun would ſeem to move in no other circle than the *equator* as the Theoriſt imagines it did before the Flood.

The next thing I am to make out is that the heat of the Sun in the *Torrid Zone*, and even in the two temperate *Zones* almoſt as far as to the 45*th* degree of Latitude, is leſs than it would have been had the Theoriſt's poſition of the earth been the true one, and this is manifeſt by the following Table Calculated by Mr. *Halley* in the above mentioned *Philoſophical Tranſactions*.

Lat.	Sun in ♈ ♎	Sun in ♋	Sun in ♑
0	20000	20290	18341
10	19696	18341	15834
20	18794	21737	13166
30	17321	22651	10124
40	15221	23048	6944
50	12855	22991	3798
60	10000	22773	1075
70	6840	23543	000
80	3473	24673	000
90	0000	25055	000

Where it plainly appears, that the aggregate of the Suns heat while he is in ♋ and ♑ and ſo in any other two oppoſite parallels, is leſs to thoſe who live in the *Torrid zone*, than if the Sun by his *diurnal* motion had deſcribed continually the *equator*.

Thus we ſee how admirably convenient the preſent poſition of the earth is upon ſeveral accounts, and how excellently it is fitted to our uſe and purpoſes above any other that we can imagine, and therefore we can never enough admire the Divine wiſdom for ſuch an excellent contrivance, This ſhews us alſo how much we ought to regard final cauſes in *Natural Philoſophy*, which in things of this nature are by far more certain and convincing than any of the *Phyſical* and *Mechanical* ones which the Theoriſt brings to prove the truth of his aſſertion, which have brought him into many ſtrange and dangerous errors, it being juſt that God Almighty ſhould deliver theſe men up to follow ſtrange deluſions, who neglecting to proceed upon final cauſes the true principles of *Natural Philoſophy*, and to ſquare their notions according to the Divine Revelations contained in Holy Scripture, have followed the wild and extravagant fancies of their own imaginations.

Another Argument which may be brought to convince the Theoriſt that the *axis* of the earth was at firſt inclined to the plane of the *ecliptick* as it is now, is, that it is certain by obſervation that *Saturn* and *Jupiter* (whom the Theoriſt will allow to have ſuffered no Deluge as yet) have their *axis* not perpendicular but inclined to the planes of their *orbits*, and the poſition is true of all the other Planets as far as they can be obſerved, and therefore it is reaſonable to ſuppoſe that the ſame muſt have been the poſition of the earth at the beginning, for where univerſally the ſame effect is obſerved, there it will be agreeable to the maxims of *Natural Philoſophy*, to aſſign the ſame cauſe, nature being uniform and not taking different methods to perform the ſame thing.

It remains now that I examin the reaſons the Theoriſt alledges to prove that the earth before the flood had its *axis* perpendicular to the plane of the *ecliptick*; it is ſays he, the immediate reſult of gravity or libration, that a body freely left to its ſelf ſhould ſettle in ſuch a poſture as beſt anſwers to its gravitation, and this earth whereof we ſpeak being uniform and every way equally ballanced, there is no reaſon why it ſhould incline at one end more than at the other towards the Sun, as if you will ſuppoſe a Ship to ſtand *North* and *South* under the *equator* if it was equally built and equally ballanced it would not incline to one Pole more than to the other but keep its *axis* parallel to the *axis* of the earth, ſo thoſe great Ships that ſail about the Sun once in ſo many years whilſt they are uniformly built and equally poiſed keep ſteady and even with the *axis* of their *orbits*, but if they looſe that equality and the centre of their gravity change the heavier end will incline more towards the centre of their motion, and the other end will recede from it, ſo particularly our earth which makes one in that airy fleet when it eſcaped ſo narrowly being ſhipwrackt in the great Deluge, was however ſo broken and diſordered that it loſt its equal poiſe and thereupon the centre of its gravity changing, one Pole became more inclined towards the Sun, and the other more removed from it, in which skew poſture it hath ſtood ever ſince.

Here the Theoriſt puts his falſe reaſoning in fine words, and dreſſes it out in gayety according to the preſent mode, that it may go the ſmoother off, but at the ſame time he ſhews us how little he is skilled either in *Aſtronomy* or *Geometry*, for he tells us in one place, that the earth *ſtands inclined to the Sun or the Ecliptick*, but how a ſphere can be inclined to a plane paſſing through its centre is far beyond my Geometry to conceive. I am ſure he will find no ſuch thing ſaid by the Geometers or the Aſtronomers before him, but he may be eaſily pardoned for this ſmall error, becauſe he *meant* well, *viz.* that the *axis* of the earth was inclin'd to the plane of the *Ecliptick*, with which it makes an angle of 66°$\frac{1}{2}$ But he has committed a far greater blunder than this which is not ſo eaſily to be forgiven him, for a World-maker ought at leaſt to underſtand ſomething of Aſtronomy and of the *Copernican* ſyſtem which he embraces, but it is plain that he does not know the Elements of that ſyſtem, ſince he aſſerts that one Pole of the earth is more inclined to the Sun than the other, this is a poſition I never heard was given to the earth before. I wiſh he would inform us which of the two Poles is moſt inclined to the Sun, for I am ſure *Copernicus*, *Kepler* and *Gallileo* the firſt revivers of the *Pythagorean* ſyſtem never ſaid any ſuch thing, they held that both Poles were equally removed from the plane of the *ecliptick*, the *axis* which joins them making with it an angle of $66^{\circ}\frac{1}{2}$ and keeping a poſition always parallel to it ſelf and therefore whatever inclination one Pole had at any time of the year to the Sun, the oppoſite Pole would have the ſame inclination at the oppoſite time of the year, and therefore both Poles are equally inclined to the Sun.

'Tis true indeed that if one hemiſphere were heavier than the other; the heavieſt Pole would always look towards the Sun to which it gravitates, and by conſequence there would be no paralleliſm obſerved in the *axis* of the earth, for if there were a Globe ſwimming in water, one of whoſe Poles were heavier than the other, it is demonſtrable that the heavieſt ſide would always be towards the centre of the earth, but ſince the earth does always keep its *axis* parallel to it ſelf, and by that means makes the variety of ſeaſons which otherwiſe would not happen, I think it a demonſtration that the Theoriſt's opinion in this point is falſe and ridiculous. For if at the Deluge the earth had loſt its equal poiſe, and its Centre of gravity had been altered as he will have it, the true effect of this alteration would be that the Pole which was next to the Centre of gravity had been always turned towards the Sun, and the people living near it had injoyed a perpetual Summer and one continued day without any night, whilſt thoſe in the oppoſite Pole had lived in perpetual darkneſs, Froſt and Snow, having but one eternal Winter without any viciſſitude of ſeaſons. Theſe therefore being the neceſſary conſequences of ſuch a change of gravity in the earth as the Theoriſt imagines, and ſince none of them did ever happen to it, but the earth does ſtill keep its *axis* parallel to it ſelf; I think it is demonſtratively evident that the earth received no ſuch *ſhock* by the Deluge as was ſufficient to alter the Centre of its gravity, and conſequently the poſition of its Poles in reſpect of the Sun.

'Tis true, a ſphere put in *æquilibration*, and made turn round about a point without any other motion, neceſſarily keeps all its diameters parallel to themſelves, and by conſequence the *axis* which is one of them muſt alſo be parallel to its ſelf, for ſince the time of its revolution is determined, it will perform its period in that time with the leaſt motion poſſible, which is only when all the diameters of the ſphere in all parts of its *orbit* are parallel to themſelves as is demonſtrated by the Geometers, Nature generally taking the ſhorteſt courſes in all its operations, at leaſt it takes that one and determinate method for performing its work, which the Philoſophers call the *unicum in natura*, I wonder therefore why ſome ſhould make a third motion for the Earth, whereby it keeps its *axis* always parallel to it ſelf, for this is rather the effect of reſt than any new motion; for it is not the paralleliſm, but the declination of the *axis* from exact paralleliſm, (by which the Stars ſeem to move tho very ſlowly according to the ſeries of the ſigns) which ought to be called a new motion.

But I will paſs from this Subject, and conſider the Theoriſts Argument for the right poſition of the Earth drawn from its *æquilibration* which he ſays is the immediate reſult and common effect of gravity or libration. For a Body ſays he freely left to its ſelf in a fluid medium will ſettle it ſelf in ſuch a poſture as will beſt anſwer to its gravity, and the Earth being uniformly ballanced, there is no reaſon why it ſhould incline at one end more than at the other towards the Sun. This he illuſtrates by the ſimilitude of a Ship equally ballanc'd, and placed *North* and *South* under the *equator*. But after all this Argument and Similitude, I can ſee as yet no reaſon why the *axis* of the Earth ſhould be perpendicular to the plane of the *Ecliptick* more than any other of its diameters, for it is demonſtrated by the writers of *Hydroſtaticks*, that a ſphere whoſe centre of Gravity is the ſame with its centre of Magnitude if put in a fluid of the ſame ſpecifick gravity with it ſelf, will retain any given poſition, and therefore there can be no reaſon drawn from the earths gravity or equilibration why the poſition of its *axis* ſhould be perpendicular to the plane of the *Ecliptick* rather than any other of its diameters.

CHAP. V.

Of Rivers.

THE Theoriſt having repreſented to us the firſt Earth as a ſmooth regular and uniform body without Mountains and without a Sea; In the *5th* Chap. of his ſecond book he ſtarts a great difficulty how it was watered, from what cauſes, and in what manner, how could Fountains riſe or Rivers flow in an Earth of that form and nature? he has ſhut up the Sea with thick walls on every ſide, and taken away all communication that could be 'twixt it and the external earth, he has removed all the Hills and Mountains where the Springs uſe to riſe, and whence the Rivers deſcend to water the face of the ground, and laſtly, he has left no iſſue for theſe Rivers, no Ocean to receive them, or any place to disburthen themſelves into. So that his new found World is like to be a dry and barren wilderneſs, and ſo far from being Paradiſaical that it would ſcarce be Habitable.

Theſe indeed are great difficulties, and the Theoriſt has acknowledged them to be ſuch, for he ſays there was nothing in his whole Theory that gave ſo rude a ſtop to his thoughts as that part of it concerning the Rivers of the firſt Earth. But as the difficulties are great, and as one would think inſuperable, ſo no doubt the glory that redounds to the Theoriſt muſt be nothing leſs, if they be clearly taken away.

To underſtand therefore what the ſtate of the primitive Rivers and waters would be, he finds it neceſſary to conſider and examine how the rains fell in the firſt Earth, and he tells us that the order of nature in the Regions of the air would be very different from what it is now; there could be no violent motions there, nor any thing that proceeded from extremity of cold, as Ice, Snow, or Hail, and as for Winds, they could neither be *impetuous* nor irregular in that Earth of his, ſeeing there were no Mountains, nor any other inequalities to obſtruct the courſe of the vapours, nor any unequal ſeaſons, nor uneqal actions of the Sun, but as for waters, meteors, dews and rains, there could not but be plenty of theſe in ſome part or other of that Earth; for the action of the Sun in raiſing vapours was very ſtrong, and very conſtant, and the Earth was at firſt moiſt and ſoft, and according

ing as it grew more dry, the rays of the Sun would pierce more deep into it, and reach at length the great abyſs which lay underneath and was an unexhauſted ſtorehouſe of new vapours. Now the ſame heat which extracted theſe vapours ſo copiouſly, would alſo hinder them from condenſing into rain in the warmer parts of the Earth, and there being no mountains or contrary winds or any ſuch cauſes, to ſtop or compreſs them, they would take their courſe where they were leaſt reſiſted, which is towards the Poles and the colder regions of the Earth; for *Eaſt* and *Weſt*, they would meet with as warm an air, and vapours as much agitated as themſelves, which therefore will not yield to their progreſs that way, but *North* and *South* they will find a more eaſy paſſage ſo that the concourſe of vapours which were raiſed chiefly about the Equinoctial and middle parts of it would be towards the extreme parts or the Poles. When theſe vapours thus driven by the heat of the Sun were arrived in the cooler Regions near the Poles they would be condenſed into rain, for wanting there the cauſe of their agitation, namely the heat of the Sun, their motion would ſoon begin to languiſh, and they would fall cloſe to one another in the form of water.

Thus he thinks he has found a ſufficient ſource for waters in the firſt earth, which would never fail, neither diminiſh nor overflow.

flow. But tho' he eſteems this an inexhauſtible ſtore-houſe, and an eaſy way to furniſh Waters, yet if it be narrowly examined he will find it not in the leaſt ſufficient for ſuch an effect.

For firſt according to his own hypotheſis there could be no Rivers for a long time after the formation of the Earth till the Sun had crackt the outward cruſt thereof, and its heat had reacht the great abyſs which the Theoriſt muſt needs own will require a very conſiderable ſpace of time, one would think it would be ſeveral hundreds of years before the Suns heat could perform ſuch an effect, during all which time the inhabitants of the Earth muſt be without waters and rivers, and lead very ſad and uncomfortable lives. Is this the fruit of the Golden Age? or is this conſiſtent with the happineſs of the antediluvian Fathers? in my opinion it is directly contrary to the Scriptures, for they give us an account of rivers immediately after the formation of the Earth.

But 2*dly*, I will hereafter prove that the Suns Beams did never yet reach ſo deep in the Earth as the thickneſs of the firſt cruſtation muſt have been, and conſequently there never could ariſe any vapours from the abyſs to furniſh the rivers.

3*dly*, Suppoſing the heat of the Sun to have crackt the cruſt, and to have raiſed vapours from the abyſs, yet it is certain it could not do it in ſuch a quantity as would be ſufficient to furniſh the Earth with waters. And now the Theoriſt will tell us, what can be more ſufficient than the whole orb of water, ſure this would do or elſe nothing could, this he will ſay is an inexhauſtible treaſure that the rivers could never drain, and therefore there was no fear of want of waters from thence. Yes there was reaſon to fear it very much, for ſuppoſing that there was enough in the abyſs, yet perhaps the action of the Sun would not raiſe ſo much as would be ſufficient to water the Earth, ſo there may be enough of Gold in the bowels of the earth, but if we cannot come at it we ſhall never be the richer for it.

That I may examine this, I will ſuppoſe the mouths of theſe cracks which the Sun is ſaid to have made by its heat to be a $\frac{1}{10000}$ part of the ſurface of the earth, this will exceed 2600 ſquare miles which I think is as much as the Theoriſt can reaſonably allow them, for if it were but one continued crack round the *equator* of a miles breadth it would not exceed 2500 miles.

2*dly*. I will ſuppoſe with the Theoriſt that one half of the ſurface of the preſent earth is Land and the other is Sea, and by conſequence the mouths of thoſe pits or cracks muſt be one five thouſandth part of the whole of the now Ocean. Now it is evident that vapours drawn by a determinate heat from any quantity of water in a determinate time are always proportionable to the ſurface of that water: for from a double ſurface there will be exhaled a double quantity of vapour, from a triple ſurface a triple quantity of vapour, and ſo on. Therefore the ſurface of the Sea being 5000 times bigger than the mouths of theſe cracks, there will be exhaled from it 5000 times more water than what in that caſe could be drawn from the abyſs. And therefore if the whole cruſt of the Antediluvian earth were but of the ſame bigneſs with our now dry land, it would have but one five thouſandth part of the water to furniſh it, that our preſent earth has; but becauſe according to the Theoriſt, the ſurface of the dry land was then twice as big as it is now, there being at that time no Ocean which takes up one half of the ſurface: therefore it is plain that any particular Country in that caſe would have ten thouſand times leſs water than it now has, there being five thouſand times fewer vapours to water a double ſurface of Land; that is, in a Country, as big as the *Iſland of Britain*, there would not be ſo much as one River, nor ſo much rain in a year as does now fall in one day.

We ſee therefore how well the Theoriſt has watered his Antediluvian earth from the inexhauſtible treaſure of the abyſs as he calls it. For however immenſe that great ſtorehouſe was, yet ſtill there would be a great ſcarcity of water on the ſurface of the earth.

Not. Except we will ſuppoſe the heat of the Sun in the primitive world conſiderably greater than it is in our earth, there muſt be leſs water drawn from the abyſs than what I ſhewed from the former Calculation, and that becauſe the Sun could not ſhine ſo long upon the ſurface of the abyſs thorow the cracks as it does now upon the Sea, by reaſon the cruſt of the earth would intercept all the rays of the Sun till it came to be of a conſiderable height as is plain by the Figure, [*Fig.* 1. *Plate* I.] Where if S repreſent the Sun in the *equator*, and P Q the ſenſible Horizon, *m n* the ſurface of the abyſs opened by the pit P *n m* R, the Sun muſt be at the height H S above the Horizon before its heat can reach the ſurface of the waters. The heat alſo upon the ſurface *n m* would not be ſo great by reaſon of the cold orb of earth which did incircle it. And upon theſe and ſome other accounts the Sun would not raiſe ſo much water from the abyſs as it does now from the ſame quantity of ſurface in the Sea, but I will not take any advantage of theſe conſiderations leaving them to be a recompence for the greater influence of the Sun which the Theoriſt ſays it had upon the Antediluvian earth.

From

Plate I.

Fig 1 P.76.121.

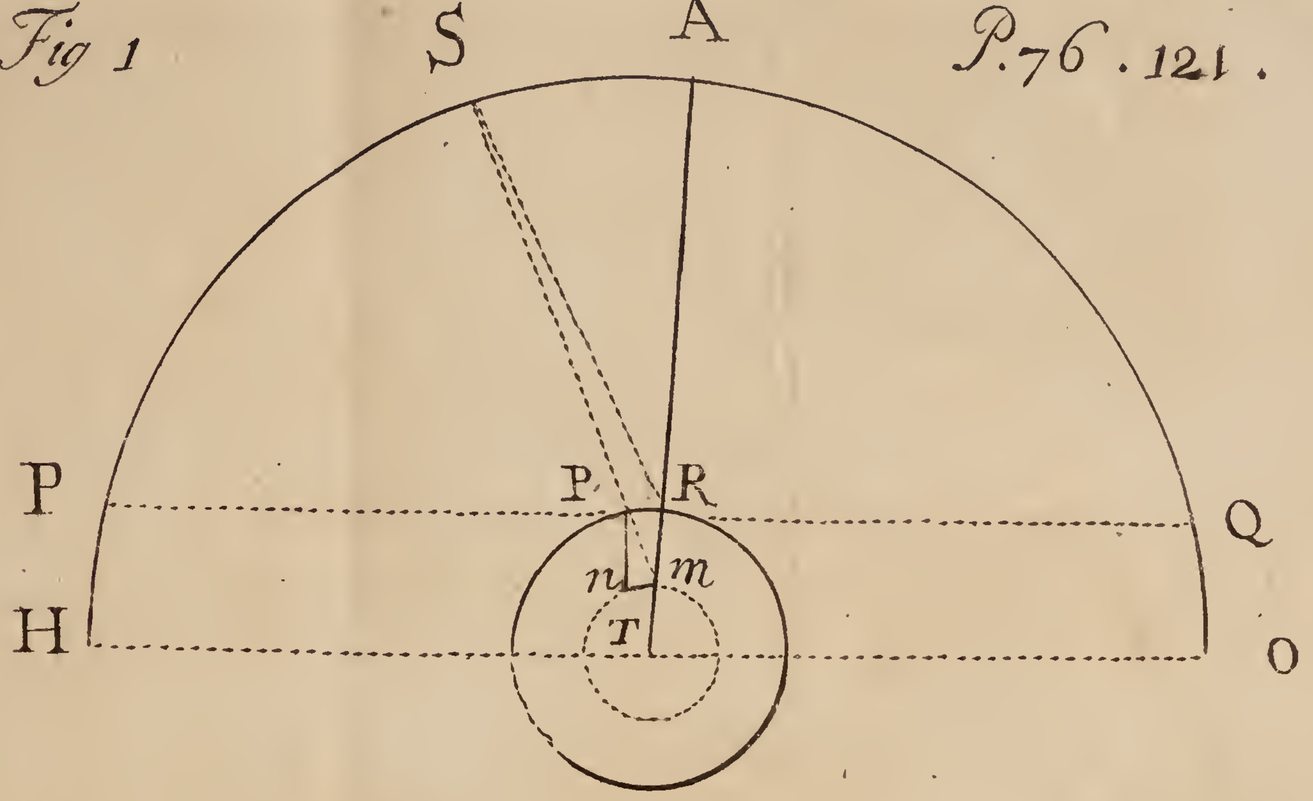
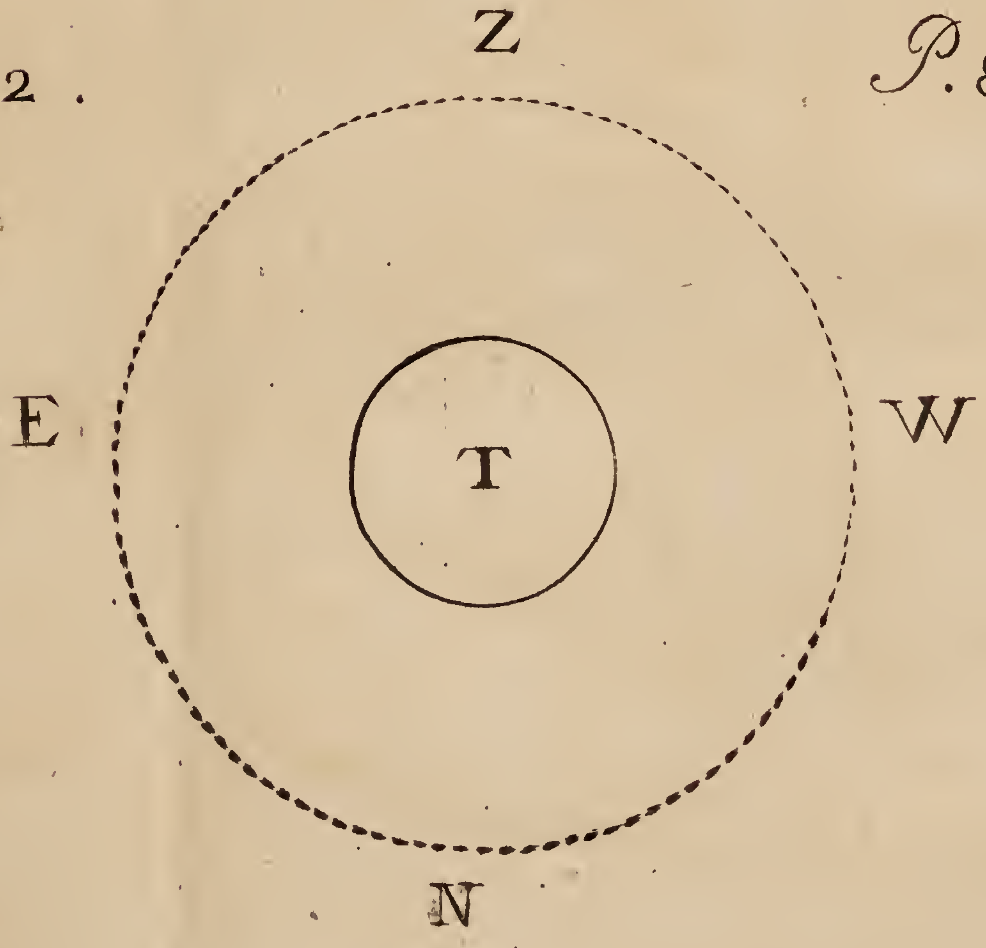


Fig. 2. P. 81.



From hence we may fully anſwer an objection of the Atheiſts againſt a providence, for ſay they, where is the wiſdom of the Creator in having ſo much uſeleſs Sea to no purpoſe and ſo little dry Land, for which men are every day fighting, might not the half of the Sea have been dry Land, which might have been ſerviceable to mankind? But this as moſt of their other arguments againſt providence proceeds from a deep ignorance of Natural Philoſophy. For if there were but half the Sea that now is, there would be alſo but half the quantity of vapours, and conſequently we could have but half ſo many Rivers as now there are, to ſupply all the dry Land we have at preſent and half as much more, The wiſe Creator therefore, did ſo prudently order it, that the Sea ſhould be large enough to ſupply vapours for all the Land, which it would not do if it were leſs than it now is.

But I will ſuppoſe with the Theoriſt that there was a quantity of vapours exhaled by the heat of the Sun from the abyſs ſufficient to furniſh plentifully the whole earth. Yet ſtill there is a great doubt how Rivers could be formed: for what ways could the vapours take their courſe to be condenſed and form Springs if there were no winds to carry them, certainly they would ſtagnate near the mouths of the cracks and leave the reſt of the earth never a whit the better for them, and every one that wanted water muſt go as far as the *equator* to fetch it. No ſays the Theoriſt there was no need for that, the vapours being very much agitated and rarified by the heat of the Sun, and being once in the open air, their courſe would be that way where they found the leaſt reſiſtance to their motion, and that would certainly be towards the Poles and colder regions of the earth, for *Eaſt* and *Weſt* they would meet with as warm an air, and vapours as much agitated as themſelves which therefore would not yield to their progreſs that way: But towards *North* and *South* they would find a more eaſy paſſage, the cold of theſe parts attracting them as we call it, that is, making way to their motion and dilatation without much reſiſtance, as mountains and cold places uſually draw vapours from the warmer.

Here is a new uſe or employment the Theoriſt has found for the Mountains and Cold to be Gentlemen-uſhers, for the vapours, and make way for their motion. He had told us before that the Cold and Hills attracted vapours, but becauſe that word was not Philoſophical, (being exploded and ridiculed by thoſe who call themſelves new Philoſophers) he explains himſelf and tells us by attraction he meant the making way for their motion and dilatation; but how a Mountain can make way to the dilatation and motion of vapours is far beyond my pitch of underſtanding, to me it ſeems reaſonable that they ſhould reſiſt both, and hinder the vapours either from moving forward or dilating themſelves. Sure I am, Cold is ſo far from being any ways conducive to the dilatation of vapours, that it does always condenſe them, as is plain by cold ſtone walls which always condenſe the vapours that fall upon them.

But the vapours ſays the Theoriſt, are very much agitated by the heat of the Sun, which gives them their motion; and therefore they would take their courſe towards the Poles where they find the leaſt reſiſtance. What other motion the heat of the Sun can give them, but upwards I cannot imagine, for by it they are raiſed and made ſpecifically lighter than the air in which they ſwim, and therefore by a known principle in Hydroſtaticks they muſt riſe till they come to air of the ſame gravity with themſelves, but then what ſhould drive them to the Poles? their great agitation ſays he, and the little reſiſtance they find that way, the air in the *Eaſt* and *Weſt* being more agitated than that towards *North* and *South*, and therefore will more reſiſt their motions.

This is a very dark anſwer, for I cannot conceive why the air upon the *North* or *South* ſide of an atome of vapour ſhould be more agitated than that upon the *Eaſt* and *Weſt* ſide, for ſure I am, there is the ſame degree of heat on all ſides of it, and therefore upon that account it ſhould find an equal reſiſtance every way. Nay the Theoriſt, or ſuch an other Philoſopher might with as good reaſon have proved, that their courſe would have been only *Eaſt* and *Weſt*, for there the air was very much rarified and made thin by the heat of the Sun, the air towards *North* and *South*, not being ſo much rarified was thicker, and therefore would reſiſt more, as water which is a thicker medium does more reſiſt the motion of bodies in it than air. This ſeems to me to be a much better grounded opinion than the Theoriſts, tho' both of them are abſolutely falſe, and may be diſprov'd by the very ſame reaſons, for how can any man fancy that vapours only driven by the heat of the Sun; would travel ſome thouſands of miles through a fluid body of air as denſe as themſelves, this ſeems to be againſt the common notions of every man, and therefore I think needs no particular calculations; I cannot but believe that the Theoriſt did ſee theſe abſurdities, ſince they are ſo very palpable, but finding no way to extricate himſelf from theſe difficulties, he was fain to make the beſt ſhift he could, which is a very bad one, and ſtill the worſe by his management.

But ſo far is the Theoriſt miſtaken in this point, that ſuppoſing the great agitation of the vapours, yet it is certain that their true courſe would be quite contrary to what he aſſerts, namely, from *Eaſt* to *Weſt*, and not towards the *North* and *South* parts of the World, for they would be carried that way by a wind, which would continually blow from *Eaſt* to *Weſt*. This I think I am able to prove demonſtratively thus.

It is well known to all the Philoſophers, that the air is a very elaſtick fluid body, ſo that being compreſt with the weight of the incumbent atmoſphere, it will endeavour to expand it ſelf, and fill up a great ſpace. If all the air therefore were equally denſe or compreſt, every part would equally reſiſt anothers preſſure, and from thence there could ariſe no motion, but if we ſhould ſuppoſe in this atmoſphere one part thinner and its tenſion weaker than the reſt, it is certain that the circumambient air, whoſe force to expand it ſelf is ſtronger, will ruſh in upon it, and keep up an equilibrium in the air. [*Fig.* 2. *Plate* I.] Now ſuppoſe E Z W N repreſent the Orb of Air, which ſurrounds the earth T, and the Sun were ſhining directly upon the Air at Z, which therefore by the great heat of the Sun will be very conſiderably more rarified and expanded than the Air at E, but afterwards the Sun ſhifting to the *Weſt*, and coming to ſhine directly upon W, the Air at Z being rarer than the Air at E, and the heat of it being gone, its tenſion or force to expand it ſelf, will not be ſo ſtrong as the tenſion of that which is at E, and therefore the Air at E, will ruſh into Z and keep up the equilibrium, Thus alſo when the Sun declines to W *Weſtward*, the heat there being greater than it is at Z, the Air there will be rarer tho' of the ſame tenſion with the Air at Z, but afterwards the Sun moving towards N, that which is at W cooles, and being rarified its tenſion will grow weaker, and therefore the Air at Z, will preſs in upon the Air at W, and condenſe it till its tenſion becomes ſo ſtrong that it is able to reſiſt any further preſſure; after the ſame manner will the Air move from W to N, and from N to E, that is, there will be a continual wind blowing from *Eaſt* to *Weſt* according to the motion of the Sun; for wind is nothing but a ſtrong ſtream of the Air moved according to ſuch a direction. But this is teſtified by the experience of all who Sail toward the *Indies*, for they find a wind in the *Atlantick* and *Æthiopick* Oceans which continually blows from *Eaſt* to *Weſt*.

Since therefore this is clearly agreeable both to reaſon and obſervations, there is no further doubt to be made of it. The wind therefore in the *Torrid Zone* of the primitive earth blowing continually from *Eaſt* to *Weſt*, muſt of neceſſity carry with it all thoſe bodies which ſwim in it, and are of the ſame denſity with it ſelf; All the vapours and exhalation therefore that can be drawn either from the abyſs or earth by the heat of the Sun, ſince they ſwim in an Air of the ſame denſity with themſelves, muſt be carried from *Eaſt* to *Weſt* by the motion of the winds, which is always directed that way.

And now I hope it will be plain even to the Theoriſt himſelf (tho' men are ſeldom convinced of the falſhood of their own notions) that the vapours which are raiſed by the Sun under the *Torrid Zone* of the primitive earth could never have reached either of the Poles, and therefore moſt part of the Inhabitants of the earth muſt ſtill have been without water ſince 'tis impoſſible any ſupplies could be brought to them from the *Æquator*.

CHAP. VI.

Of the Figure of the Earth.

THE Theoriſt as he thinks having found a ſufficient ſtock of waters for the ſupply of all the Rivers in the earth, does now enter upon the ſolution of another great difficulty, which is to ſhew, how in a ſmooth and regular earth the waters could run, and what way they would take their courſe after their arrival at the Poles in vapour;

pour; for ſince there were no Hills, nor Mountains, nor high Lands, in the firſt Earth, the vapours falling in the Frigid Zones and towards the Poles, there it ſeems they would ſtand in Lakes and Pooles, having no deſcent one way more than another. The Theoriſt therefore to take off the objection, will have the earth not to be of an exact Spherical, but an Oval figure, in which he ſays it is manifeſt that the Polar parts are higher than the Æquinoctial, that is more remote from the Centre as appears by his figure, and this he tells us will do the buſineſs, For by that means the vapours which fall at the extream parts of the earth will have a continual deſcent towards the middle parts thereof, and by conſequence it will be a ſufficient deſcent for the running of Rivers.

Now I will readily grant that the figure of the earth is not Spherical but Spheroidical, but I can ſee no reaſon why it ſhould be an oblong Spheroid and not a broad one, for it may be of a Spheroidical figure, tho' the Axis of it were ſhorter than the Diameter of its equator, and if it were ſo, I would fain know by what means the vapours would flow from the Poles to the Equator.

But the Theoriſt gives us an account how the Earth came to be formed after the faſhion of an oblong Spheroid. 'Tis true ſays he, if the Earth were as fluid a *ſubſtance* as it was in the Creation and ſtood immoveable without

out turning round its own Axis it would certainly ſettle it ſelf into a Spherical figure, but becauſe it turned very ſwiftly round its Axis, the Fluid by that agitation would endeavour to recede from its Centre of motion, and form it ſelf into a figure very nearly Oval, as we ſee in the Sea, or in any Lake when the waters are driven by the wind upon the Land the Waves extend themſelves in length, ſo in our watery Globe which is turned about its own Axis, the whole bulk of water under the equator being much more agitated than that which is towards the Poles (where the fluid in its diurnal motion deſcribes leſſer circles) it will endeavour to recede from the Centre of its motion, and becauſe it cannot get quite off and fly away, by reaſon of the Air which every way preſſes upon it, and the ſtraitneſs of its Orb in theſe places, neither could it flow back without a great check and reſiſtance from the ſame Air, it could not otherwiſe free it ſelf than by flowing towards the ſides, for waters which are hindered in their motion will take the eaſieſt courſe they can have. Now from this detruſion of the waters towards the ſide, the parts towards the Poles muſt come to be much increaſed, and thoſe towards the equator diſcharged of abundance of water, which otherwiſe would have lain upon them, and by conſequence the earth muſt have been of an Oblong or an Oval figure.

Now ſuppoſing all this reaſoning true and ſolid (as indeed it is not) that the earth by its circum-rotation round its Axis, had formed it ſelf into the figure of an Oblong Spheroid. Yet ſtill I cannot conceive how this will help the matter, for even in that caſe, the waters would not flow from the Pole to the Æquator: Yes they will ſays the Theoriſt, ſince all fluids will deſcend as far as they can, and this is the only way of deſcent by which they come nearer to the Centre than by any other. 'Tis certainly true indeed that all fluids will deſcend continually till they meet with ſome obſtacle which reſiſts their motion downwards, where they muſt ſtop and go no further. And this is the reaſon why in our preſent caſe there could be no motion or flux of the Rivers from the Pole to the Æquator. For the rotation of the earth round its own Axis being ſtill the ſame, the cauſe which thruſts the water from the Æquator to the Pole will alſo continue the ſame and invariable, and by conſequence it will hinder the water from returning again towards the Æquator. And therefore ſuppoſing that the Earth were formed into an Oval figure, yet could there not be any courſe for Rivers; for only ſo far would the water aſcend towards the Poles, till the force which protruded it that way came to be in an Æquilibrium with its gravity, and there it would ſtop neither aſcending any further,

Plate II.

Fig.3. *P.87.92.*

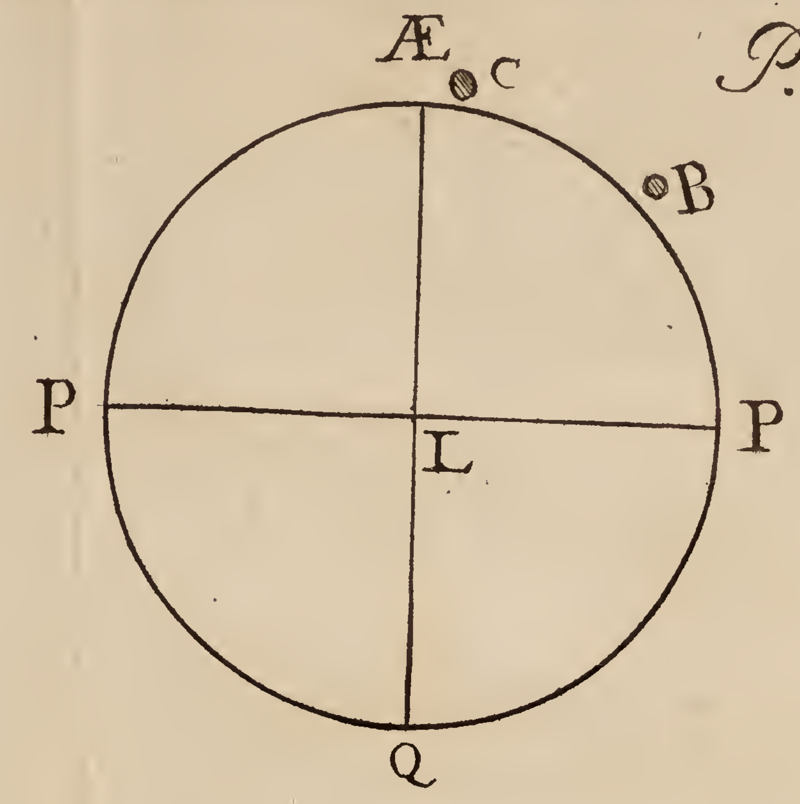


Fig.4. *P.93.*

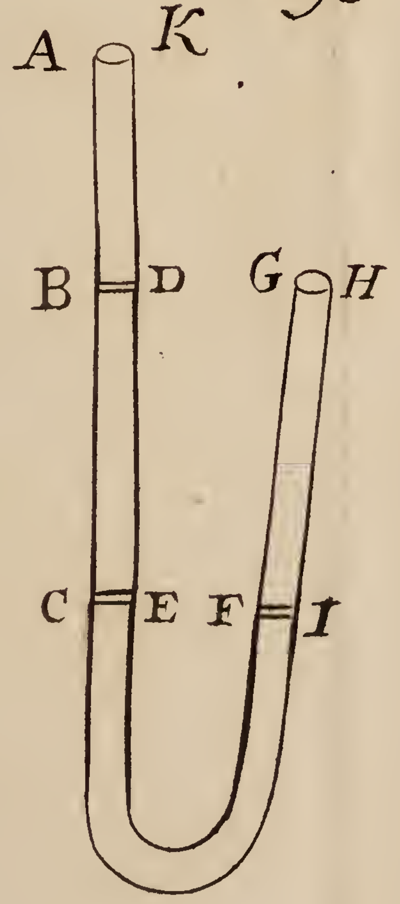
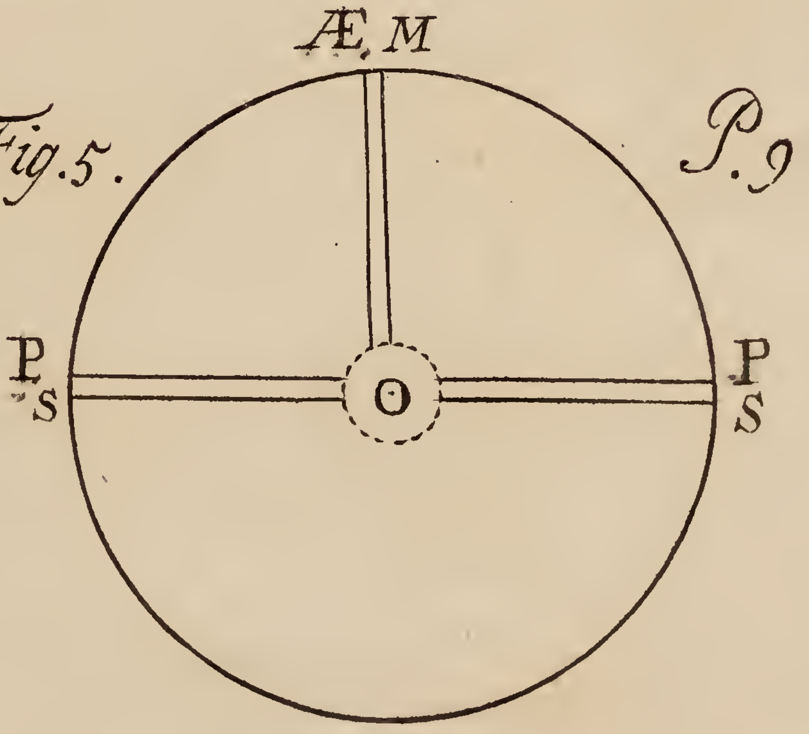


Fig.5. *P.94.*



nor deſcending again as long as the ſame cauſe continued to act; that is, as long as the Earth turns round its own Axis in the ſpace of twenty four hours, but if the Earth ſhould ceaſe to move round, then indeed in that caſe and no other, the water would return to the Æquator. For let the Figure, [*Fig.* 3. *Plate* II.] P Æ P Q repreſent the Earth, P P the two Poles, and Æ Q the Æquator, and B a Body upon the ſurface of the Earth, I think it is evident that the Body B will ſo far aſcend towards the Poles, till the force which protrudes it that way be in æquilibrium with the force which draws it to the æquator: for if at B one were greater than the other, for example, the force by which it is drawn to the Poles, were greater than its gravity, or its tendency towards Æ, then it would ſtill move on towards the Pole, till both forces come to act equally and there it would reſt, as long as theſe two forces continued in Æquilibrium which muſt be ſo long as the Earths diurnal motion laſts. Now whatever Bodies either ſolid or fluid, are brought and laid upon the ſurface of the Earth at B, theſe being drawn or puſht with the ſame accelerating force, either to the Pole or the Æquator, that the firſt fluid had, which was conſtituted at B, the ſame cauſes continuing to act upon both, they will reſt there alſo, and conſequently will not deſcend to the Æquator. Thus I think I have made it evident from the Theoriſts own principles, and his Oval figure of the Earth, that there could be no courſe of Rivers in the Antediluvian world, if his Theory were true, and therefore ſeeing there were Rivers then as well as now, for he himſelf has acknowledged them, and it is plainly aſſerted by the Scriptures that they were from the beginning, I think it is a certain demonſtration that the whole account of his Antediluvian Earth is falſe and Chimerical.

I come now to examin the Theoriſts reaſons by which he proves the Earth to be of an Oblong Spheroidical figure. He tells us that the fluid under the æquator being much more agitated than that which is towards the Poles which deſcribes in its diurnal motions leſſer arches, and becauſe it cannot quite get off and fly away by reaſon of the Air which every way preſſes upon it, it could no other ways free it ſelf than by flowing towards the ſides, and conſequently form the Earth into an Oval figure.

That the Reader may obſerve how excellent the Theoriſt is at drawing concluſions, I will put this reaſoning in other words thus. All Bodies by reaſon of the Earths diurnal rotation, do endeavour to recede from the Axis of their motion; but by reaſon of the preſſure of the Air, and the ſtraightneſs of the Orb, they cannot recede from the Axis of their motion, therefore they will move towards the Poles where they will come nearer to the Axis of their motion, as if you would ſuppoſe a Body at the Æquator which doth endeavour to recede from the Axis of its motion, but becauſe it cannot quite fly off and get away, therefore it will move towards the Poles, that is, it will come nearer to the Axis of its motion than if it had ſtayed at the Æquator. It ſeems to me that the Theoriſt in this part has endeavoured to give us a proof of his great skill in Logicks, for he from a poſſible ſuppoſition, has endeavoured directly to prove its contradictory, that is, becauſe all Bodies do endeavour to recede from the Axis of their motion, therefore they will endeavour to go to the Axis of their motion. But I will now examin his Argument more particularly, and firſt I will grant to the Theoriſt, that all Bodies turned round about any Centre do endeavour to recede from it and fly off in the tangent. For this is both evident to reaſon and experience; but ſince the Air does always move round the Earth, it is plain that it will alſo endeavour to recede from the Centre of its motion, and by conſequence, it will be no hinderance to the water to do the ſame, neither can it be ſaid, that the ſtraitneſs of the Orb will hinder the fluid from receding, ſince there is no reaſon to aſſign any ſuch ſtrait limits to our Globe, for our Air is not encloſ'd with walls, but beyond our Atmoſphere there lyes a free and open ſpace: beſides if there were any ſuch ſtraitneſs, without doubt it would be every where equal and the ſame, and by conſequence, as it hindered the fluid from riſing at the Æquator, ſo it would alſo hinder its riſing at the Poles, and then there would not in that caſe be any Oval figure at all.

I am ſure the Theoriſt can give no reaſon why he ſhould make the Air reſiſt the motion of the fluid upwards at the Æquator, and yet yield to its motion upwards at the Poles, ſince 'tis certain that the Air preſſes as much one way as another: it will by the ſame force hinder a fluid from riſing at the Pole, by which it reſiſted its riſing at the Æquator, and therefore it is plain, that the Earth could not upon any ſuch account be of an Oblong Spheroidical figure, whoſe ſurface at the Æquator is nearer its Centre than its Poles are.

So far is the Theoriſts Opinion diſtant from truth in this point, that from the ſame very principle of a Centrifugal force it does evidently follow that the ſurface of the Earth towards the Æquator is higher or further diſtant from the Centre than it is at the Poles, which is directly contrary to that figure which he ſuppoſes it had in its primitive ſtate. Now to prove this, I will ſuppoſe firſt, that at the begining of the world the Earth was fluid and ſpherical, but afterwards God Almighty having given it a motion round its own

Axis, all Bodies upon the Earth would deſcribe either the Æquator, or Circles parallel to the Æquator, and by conſequence all would endeavour to recede from the Centre of their motion.

It is to be here obſerved, that if a Body doth freely revolve in a Circle about a Centre as the Planets do about the Sun, that its centrifugal force, (or that force by which it is drawn towards the Centre) is always equal to its centrifugal force by which it doth endeavour to recede from the Centre: for the force which detains a Body in its orbit muſt be equal to the force, by which it endeavours to recede from its orbit and fly off in the tangent. This may be clear by the example of a Body turned round a Centre by the help of a thread which detains the Body in its orbit; the thread being ſtretched by the motion of the Body will endeavour to contract it ſelf equally towards both ends by which it pull the Centre as much towards the Body as it doth the Body towards the Centre.

Now this Centrifugal force is always proportional to the periphery which each Body deſcribes in its diurnal motion by the firſt Theor. of *Hugenius De vi Centrifuga:* ſo that under the Æquator which is the biggeſt circle the centrifugal force would be greateſt, and ſtill grow leſs as we approach the Pole where it quite vaniſheth, there being there no diurnal rotation. And without doubt all Bodies having this centrifugal force by which they endeavour to recede from the Centre of their motion, would fly off from the Earth if they were not kept in their orbit, by their gravity, or that force by which they are preſſed towards the Centre of the Earth, which is much ſtronger upon our Earth than the centrifugal force; and becauſe the gravity upon the ſurface of the Earth is always the ſame, but the centrifugal force alters and grows leſs the nearer we come to the Poles; it is plain that the gravity under the æquator having a greater force to oppoſe it than that which is near the Poles, will not act ſo ſtrongly in the one place as in the other, and conſequently bodies will not be ſo heavy under the æquator as at the Poles.

If the Circle * Æ P Q P repreſent the Earth, Æ Q the æquator, and *P P* the Poles, if C be a Body in the æquator, it is evident that it will be pulled down by two contrary forces, namely that of its gravity which pulls it towards the Centre, and that of its centrifugal force which pulls it from it. Now if both theſe forces were equal it is evident it would go neither of theſe ways; but if one were ſtronger than the other, it would move where the ſtrongeſt force pulls it, but only with a velocity which is proportional to the differences of theſe two forces, and therefore it would not deſcend ſo faſt as if there were no centrifugal force pulling againſt it. That is a Body in the Æquator does preſs leſs towards the Centre than at the Pole where there is no centrifugal force to leſſen its gravity. Bodies therefore of the ſame denſity are not ſo heavy in one place as in the other.

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* *See Figure* 3. *Plate* II.

Now in a ſpherical fluid, all whoſe parts gravitate towards the Centre, I think it is evident from the principles of Hydroſtaticks and fluidity, that all thoſe Bodies which are equally diſtant from the Centre, muſt be equally preſt with the weight of the incumbent fluid, and if one part come to be more preſſed than another, that which is moſt preſſed will thruſt that out of its place which is leaſt, till all the parts come to an æquilibrium one with another, and this is known by a common and eaſy experiment, if you take a recurved tube as in the figure, [*Fig.* 4. *Plate* II.] and fill it with water or any other fluid, it will riſe equally in both Legs of the Tube, ſo that the ſurfaces C E and F I are equally preſſed by the weight of the incumbent columns B C E D, G F I H, but if one of the Legs of this Tube ſhould be filled with oil, or ſome other lighter fluid, and the other with water, the lighter fluid will riſe higher than the other, for otherways, theſe ſurfaces which are equally diſtant from the Centre could not be equally preſſed.

Juſt ſo, if the Figure [*Fig.* 5. *Plate* II.] P Æ M P S repreſent a fluid ſphere, which we may imagin compoſed of a great many communicating Canals or Tubes, the fluid in every one of which preſſes upon the Centre, now if the fluid in every one of theſe Tubes was of equal weight or gravity, it is plain that by that means they would be alſo of an equal height from the Centre; for by that means only would the Centre be equally preſſed by the weight of all the Tubes; but if the fluid in the canal Æ O M were lighter than the fluid in the canal P O S, it is plain that in this caſe the fluid P O S preſſing more on the Centre than the fluid in Æ O M, the ſurface of the fluid in the canal Æ O M will riſe to a greater height or diſtance from the Centre, ſo that by its greater height which recompenſes its leſſer gravitation it will preſs equally upon the Centre, with the fluid in the canal P O S. After the ſame manner * if the fluid in the canal G O H, were heavier than the fluid in the canal Æ O M, but lighter than that which is in P O S, then would the canal, G O H be ſhorter than Æ O M but longer than P O S, and the Figure compoſed of all theſe Tubes would be in the form of a ſpheroid which is generated by the circumrotation of a *ſemi elipſis* round its axis, but as I have already ſhowed that if Æ O M repreſent the ſemidiameter

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* *See Figure* 6. *Plate* III.

Plate III.

Fig. 6.

P. 94.95.

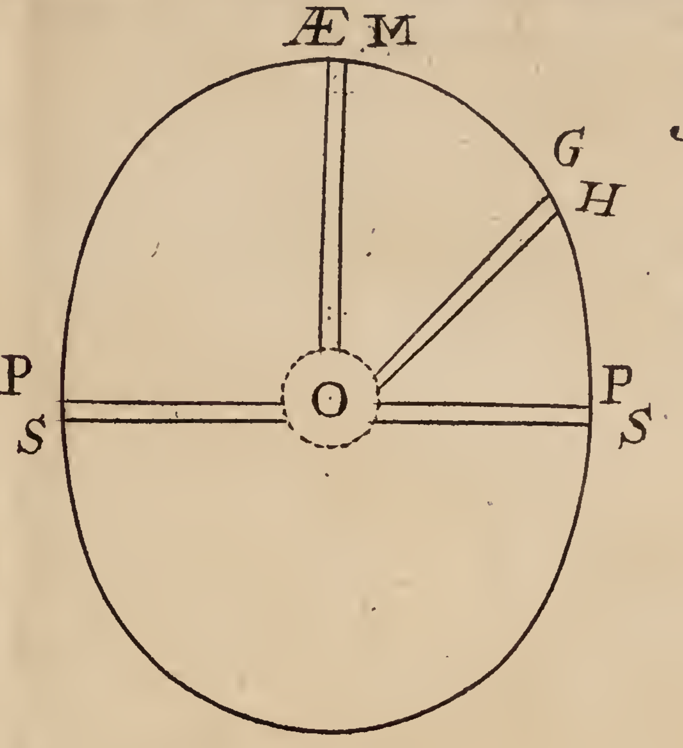
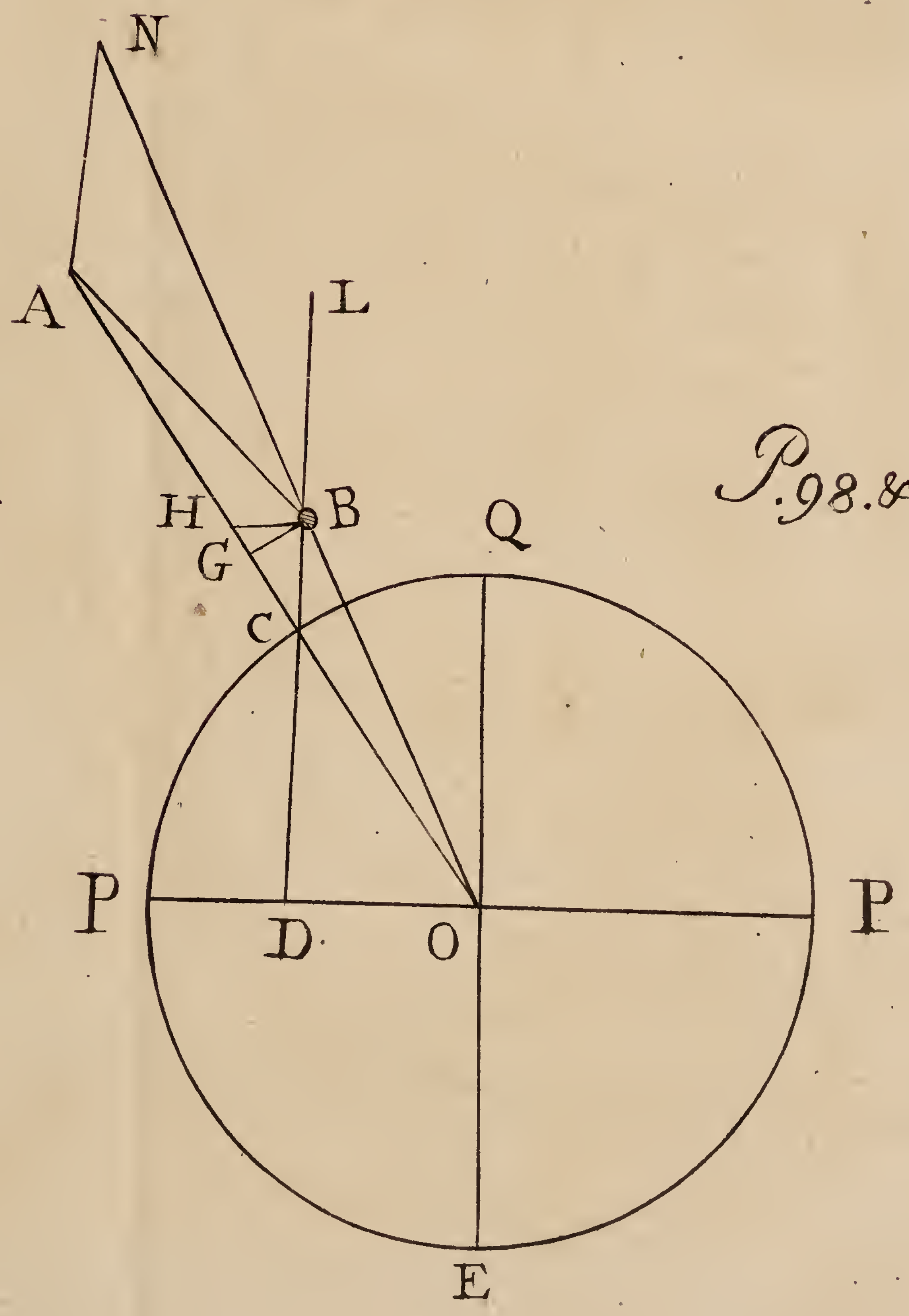


Fig. 7.

P. 98. &c.



meter of the Æquator, that all Bodies in it are lighter than in P O S, the Axis of the Æquator (we take the Diameters and Axis here not as pure Mathematical lines, but as ſmall Canals or Tubes,) and juſt ſo thoſe Bodies which are in the Tube G O H, I have proved to be lighter than thoſe in P O S, but heavier than the Bodies which are in Æ O M, the centrifugal force in G H, being leſs than that which is in Æ M, and there is no centrifugal force in the Poles, P S. It is plain therefore that the Tube Æ O M, will be longer than G O H, and G O H will be longer than P O S, that is, the Diameter of the Æquator will be longer than the Axis of the Earth, and conſequently the Figure of [*Fig.* 6. *Plate* III.] the Earth will be after the faſhion of a broad ſpheroid which is generated by the rotation of a ſemi Ellipſis round its leſſer Axis. This I hope will be ſufficient to convince the Theoriſt of the falſeneſs of his own aſſertion, ſince it is plain demonſtration, that an Earth formed from a Chaos muſt have a very different Figure from what he ſuppoſes it had.

But I will now proceed farther and enquire, how much the gravity is diminiſhed at the Æquator, or any other parallel by the centrifugal force, which all bodies acquire by being turned round the Earths Axis, that from thence we may endeavour to determine what proportion the Diameter of the Earths Æquator has to its Axis, to Calculate which, I will firſt ſuppoſe that the mean ſemidiameter of the Earth is 19615800 *Paris* feet according to the late obſervations of the *French Mathematicians*, and ſince the Earth turns round its Axis in the ſpace of 23 hours 56′, for in that time the ſame meridian returns to the ſame immoveable point of the Heaven again (but the Sun in the mean time ſeeming to be moved a degree according to the ſeries of the ſigns is the cauſe why there is four minutes more required, before the meridian can overtake him) from thence it follows, that a Body under the Æquator moves through 142688 feet in the ſpace of one ſecond of time. Now according to the Theorem given us by Mr. *Newton* in his *Philoſophiæ Naturalis principia Mathematicia Schol. prop.* 4. *Lib.* 1. The centrifugal force of any body, has the ſame proportion to the force of gravity, that the ſquare of the arch which a body deſcribes in a given time divided by its diameter, has to the ſpace through which a heavy body moves in falling from a place in which it was at reſt in the ſame time, and ſuppoſing a heavy body falls 15 foot in a ſecond of time, by Calculation it will from thence follow, that the force of gravity has the ſame proportion to the centrifugal force at the Æquator, that 289 has to unity; and therefore by this centrifugal force which ariſes from the Diurnal rotation of the Earth round its axis, any body placed in the Æquator loſes $\frac{1}{289}$ part of its gravity which it would have were the Earth at reſt, or which is the ſame thing, a heavy body placed at either of the Poles (where there is no diurnal rotation, and conſequently no centrifugal force,) which weighs 289 pounds if it were brought to the Æquator will weigh only 288 pounds.

Having thus determined the proportion of the centrifugal force at the Æquator to the force of gravity, it will be eaſy from thence to ſhew their proportions in any parallel, for it is compounded of the proportion of 1 to 289, and of the co-ſine of the Latitude to the Radius; for if two bodies deſcribe different peripheries in the ſame time, their centrifugal forces are proportional to their peripheries or to the ſemi-diameters of theſe Peripheries, as is determined by Monſ. *Hugens* in his *Theoremata de vi centrifuga & motu circulari*: but the Periphery which a body in the æquator deſcribes has its ſemi-diameter equal to the radius or ſemi-diameter of the Earth, and in any other place the parallels in which Bodies move have the co-ſines of their Latitude for their ſemi-diameters, and therefore it will follow that the force of gravity is to the centrifugal force in a proportion compounded of the radius to the co-ſine of the Latitude and of 289 to 1. and therefore at the Latitude of 51 degrees, 46 minutes (for example) it will be as 466 to 1.

But we muſt obſerve that it does not from thence follow, that a body in that Latitude loſes $\frac{1}{466}$ part of its abſolute gravity which it would have were the Earth at reſt; for that could not be, unleſs the centrifugal force acted directly contrary to the force of gravity, which it doth no where but at the Æquator, for in the Figure [*Fig.* 7. *Plate* III.] let the circle Q P E repreſent the Earth, Q E the diameter of the Æquator, O its Centre, and let B repreſent a Body which we ſuppoſe to hang by the thread A B, and is placed any where between the Pole P and the Æquator Q, and let B D be drawn perpendicular to the axis. It is plain that if the Earth had no diurnal rotation, the Body B would draw the thread A B into the poſition A C, ſince by that means it deſcends as near as it can to the Centre, and there it would ſtretch the thread with all the force of its gravity; or if we will ſuppoſe that the centrifugal force acted according to the ſame direction A C, it would then directly oppoſe the force of gravity, and the thread would remain in the ſame poſition, but it would be ſtretched with a force proportional to the differences of theſe two forces.

But becauſe the Body B turns round the Centre D, it will endeavour to recede from it according to the line C B, in which direction the centrifugal force acting, it will not directly oppoſe the force of gravity, but it will draw the thread from the poſition A C into the poſition A B, let B G be drawn perpendicular to A C. If B C repreſent the centrifugal force acting according to the direction B C, it is equivalent, as is commonly known, to two forces one of which is as G C, and acts according to the direction G C, which is contrary to that by which it deſcends to O, the other is as G B, and acts according to the direction G B, which is no way contrary to the force of gravity, If therefore B C repreſent the total centrifugal force of the Body B, that part of it which directly oppoſes the force of gravity will be as G C: from whence it follows, that the decreaſe of gravity in going from the Pole to the Æquator is always as the ſquare of the co-ſine of the Latitude: for draw B H parallel to the Axis P P, and becauſe the triangles H C B, C D O are æquiangular, therefore H C is to C B as C O is to C D, or as Q O is to C D, but Q O is to C D as the decreaſe of gravity at Q is to the centrifugal force at C, and therefore H C is to C B as the decreaſe of gravity at Q is to the centrifugal force at C. But if C B repreſent the centrifugal force at C, G C will repreſent that part of it which acts directly againſt the force of gravity, and conſequently the decreaſe of gravity at the Æquator is to the decreaſe of gravity at C as H C is to G C: now H C is to G C in duplicate proportion of H C to C B, or of C O, or O Q to C D, by the 8*th* of the 6*th* of *Euclid*; and therefore the decreaſe of gravity at Q is to the decreaſe of gravity at C, as the ſquare of C O is to the ſquare of C D which was to be demonſtrated.

From whence it is plain that if H C repreſent the decreaſe of gravity at the Æquator, and G C its decreaſe at C, then will G H repreſent the difference of theſe two diminutions, or the difference between the gravity at Q and the gravity at C, but H C is to H G in duplicate proportion of H C to H B, or of O C to D O, that is, the decreaſe of gravity at the Æquator is to its increaſe at C, as the ſquare of the radius is to the ſquare of the ſine of the Latitude.

By this alſo it will appear that the direction of heavy Bodies is not to the Centre of the Earth, as has been always ſuppoſed, For if we take a heavy Body and hang it by a thread, the thread produced will not paſs through the Centre any where but at the Poles and the Æquator, for in the Figure the thread is carried by the centrifugal force of the Body B from the poſition A C, into the poſition A B where it will reſt.

Now to determine the angle C A B which the line of direction of the Body makes with the line A C, let A N be drawn parallel to B C, and produce O B till it meet with it in N, and let us conſider the Body B as drawn by three powers according to three different directions BO BL and AB, the power which pulls it according to BO is its gravity, that which draws it according to the direction BL is its centrifugal force, and that which acts according to AB is the ſtrength of the thread, by which the Body is hindered to move according to either of the other two directions, and therefore it is an æquilibrium with the other two powers, but by a Theorem which is demonſtrated by ſeveral of the writers of Mechanics, but particularly by Monſ. *Hugens* in his ſmall Treatiſe *De potentiis per fila trahentibus.* If a Body be pulled by three different powers which are in *æquilibrio* with one another, according to three different directions AB, BK, and BO, theſe three powers will be as the three ſides of the Triangle ABN, *viz.* as AB, AN, and BN reſpectively; or as AB, BC and AC: BN being very near parallel, and conſequently equal to AC, ſince they do not meet but at a great diſtance. From hence it follows that the force of gravity is to the centrifugal force as, AC is to BC: but a method has been already ſhown how the proportion of the force of gravity to the centrifugal force may be determined, and therefore the proportion of AC to BC, may be alſo determined, which at the Latitude of 51°, 46″, is as 446 to 1. Therefore in the Triangle ABC, the proportion of AC to BC is known and the angle ACB being equal to the angle C O Q which is ſubtended by the arch C Q the Latitude of the place, from thence by the Tables of Sines and Tangents the angle B A C may be known, which in the above mentioned Latitude is about five minutes.

From hence alſo it will appear that it is not the line A C, which being produced paſſes through the Centre, but the line A B that is perpendicular to the curve P Q, for all the particles of the fluid will ſettle themſelves in ſuch a poſition that their lines of direction downwards muſt be perpendicular to the ſurface of the Body which they compoſe, for otherwiſe the parts of the fluid would not be in an Æquilibrium one with another, and therefore altho' the lines of direction of heavy Bodies do not paſs through the Centre of the Earth, yet are they ſtill perpendicular to their Horizons, and upon this account there could ariſe no error in levelling of lines, and in finding the riſings and fallings of the ground.

Upon this account alſo it will appear that the ſurface of the Earth is not ſpherical, for if it were, then would all lines drawn from the Centre be perpendicular to the ſurface of the Earth, ſince it is the known property of a ſphere that they muſt be ſo, but I have already ſhewed that it is not ſo in the Earth, and therefore it is plain that the Earth is not a Sphere. That therefore I may enquire more particularly into the Figure of the Earth, I will reſume my former hypotheſis, that the Earth is compoſed of an infinite number of Canals which communicate with one another at the Centre and are all equiponderant, of which we will conſider two as O Q and O C, and let O Q be = r, O D = x and D C = y, let the abſolute gravity be called p, and the centrifugal force at the Æquator n, O C is equal to $\sqrt{x^2+y^2}$, the weight of the Canal O Q is equal to the abſolute gravity of the whole canal, *minus* the centrifugal force of each particle contained in it, and becauſe the centrifugal force of each particle is as its diſtance from the Centre, and therefore it increaſes in an Arithmetical progreſſion, the greateſt of which is n, conſequently the ſum of all the centrifugal force is $= \frac{1}{2}nr$, but upon the hypotheſis, that gravity is the ſame at all diſtances from the Centre, the abſolute gravity of the canal O Q is pr, and therefore its real weight upon the Centre O Q is $pr - \frac{1}{2}nr$. After the ſame manner the abſolute gravity of the canal O C is $p \times \sqrt{x^2+y^2}$ but the ſumm of the centrifugal forces of all the fluid in the canal O C is equal to the centrifugal force of the fluid in C D (as may be eaſily proved from the conſideration of inclined Planes) But the centrifugal force at C being to the centrifugal force at Q as C D is to O Q (that is, as y is to r) the centrifugal force at C will be equal to $\frac{ny}{r}$ and becauſe the centrifugal force of each Particle is as its diſtance from the point D which is the Centre of the Circle, that the fluid in the canal C D deſcribes, and therefore the centrifugal forces in counting from the point D muſt increaſe in an Arithmetical progreſſion, the greateſt of which is $\frac{ny}{r}$ and therefore the ſumm of all the centrifugal forces in C D muſt be equal to $\frac{nyy}{2r}$ therefore the weight of the canal O C is $=p\sqrt{x^2+y^2}-\frac{1}{2}\frac{nyy}{r}=pr-\frac{1}{2}nr$ which equation expreſſes the nature of the curve that is made by the ſection of the earth with a plane through its poles, and by this, the proportion of the axis of the earth to the diameter of the æquator may be eaſily determined; for when C O coincides with O P, then C D or y becomes equal to nothing, and the equation is $p\sqrt{x^2}=pr-\frac{1}{2}nr$ or $px=pr-\frac{1}{2}nr$, and therefore by the *16th* of the *6th* p has the ſame proportion to $p-\frac{1}{2}n$ that r has to x or O Q to O D, but p is to $p-\frac{1}{2}n$ as 289 is to $288\frac{1}{2}$ or as 578 to 577 which therefore is the proportion of the greateſt diameter of the Earth to its leaſt; but this is upon ſuppoſition that gravity is the ſame at all diſtances from the Centre, but if we will ſuppoſe that the gravity of bodies without the Earth is in a proportion reciprocal to the ſquares of their diſtances from the Centre, the gravity of thoſe bodies which are within the Earth will be directly as their diſtance, both which do beſt agree with the obſerv'd Phænomena of nature; then will the gravity at the Æquator be to the gravity at the Poles as *689* to *692*, which numbers in this Hypotheſis do alſo expreſs the proportion of the Diameter of the Earth drawn through its Poles to its Diameter drawn in the plane of the Æquator.

It is upon the account of this diminution of gravity, according as we approach the Æquator, that pendulums of the ſame length in different Latitudes, take different times, to perform their vibrations; for becauſe the accelerating force of gravity is leſs at the Æquator than under any parallel, and under any parallel it is ſtill leſs than under another which is nearer the Poles, it do's plainly from thence follow that a body plac'd in the Æquator, or in any parallel will take a longer time to deſcend through an arch of a given circle, than it would do at the Poles, and the farther a body is removed from the Poles, the longer time it will take to deſcend through any given ſpace.

From hence it follows that the length of pendulums which perform their vibrations in equal times in different Latitudes are directly as the accelerating forces of their gravities. For the time a Body takes to deſcend through an Arch of a Cycloid, is to the time it will take to fall through the Axis of the Cycloid always in a given proportion, *viz.* as the Semiperiphery of a circle is to its Diameter by the 25*th Prop.* of *Hugens Horologium Oſcillatorium*; and therefore when the times in which a body deſcends through the Axis of two different Cycloids are equal, the times of the deſcent through the Cycloids will be alſo equal, but when the times of the deſcent through the Axes are equal, theſe Axes, and conſequently the lengths of the pendulum which vibrates in theſe Cycloids are proportional to the accelerating forces of their gravities.

By this, if we know the length of a pendulum which performs its vibrations in a given time, in any one part of the Earth, it is eaſy to determine the length of a pendulum which performs its vibrations in the ſame time, in any other part of the Earth, as for example: the length of a pendulum which vibrates ſeconds at *Paris* is three foot eight lines and an half, let it be required to find the length of a pendulum which vibrates ſeconds at the Equator. Becauſe the gravity at the Pole is to the gravity at the Æquator as *692* is to *689*, therefore the decreaſe of gravity at the Æquator is $\frac{3}{692}$ parts of the whole gravity: but as I have before demonſtrated the decreaſe of gravity at the Æquator is to its increaſe in any other Latitude, as the ſquare of the radius is to the ſquare of the ſine of the Latitude; now the Latitude of *Paris* being 48°. 45′ its ſine is 75. 183, and therefore the ſquare of the Radius is to the ſquare of the ſine of the Latitude as 1000000 to 565248, but as 1000000 is to 565248, ſo is 3.000 the number which repreſents the decreaſe of gravity at the Æquator to 1. *695*, the number which repreſents its increaſe at *Paris* which added to *689* the gravity at the Æquator makes *690. 695* the number which will repreſent the gravity at *Paris*. But I have already ſhewed, that as the gravity at *Paris* is to the gravity at the Æquator, ſo is the length of a pendulum which vibrates ſeconds at *Paris* to the length of a pendulum which vibrates ſeconds at the Æquator, that is as *690*, *695* to *689*, ſo is 36, 708 the length of a pendulum at *Paris* which performs its vibration in a ſecond to 36, *616*, which therefore is the length of a pendulum which performs its vibrations in a ſecond at the Æquator: ſo that the difference between theſe two pendulums is $\frac{92}{1000}$ parts of an inch which comes pretty near the obſervations of *Monſ. Richer*, who at the Iſland of *Cayen*, whoſe Latitude is 5 degrees, found that a pendulum which vibrates ſeconds there, was a tenth part of an inch ſhorter than a pendulum which vibrates ſeconds at *Paris.*

Thus we ſee that the principles and hypotheſis and withal their conſequences upon which the broad Spheroidical Figure of the Earth is founded do exactly agree with obſervations, and therefore there is no doubt to be made but that the Earth is really of ſuch a Figure, and that the hypotheſis upon which this Figure is grounded (*viz.* the diurnal rotation of the Earth and by conſequence the centrifugal force of all Bodies upon it) muſt be admitted for a true one; ſince the different vibrations of Pendulums of the ſame length in different Latitudes can depend upon no other cauſe: for the change of Air is not able to produce any ſuch effect, for if the Air made really any alterations in the vibrations of a Pendulum it would produce a quite contrary effect, than what is obſerved; for Pendulums near the Æquator would move faſter than they would do in places of greater Latitude; the Air in the one place being more rarified is much thinner and finer than it is in the other, and therefore gives leſs reſiſtance to Bodies which move in it.

In this reaſoning we have ſuppoſed the Earth to have been at firſt fluid as the Theoriſt has done before us, but if we will put the caſe that the Earth was at firſt partly fluid and partly dry as it is at preſent, yet becauſe we find that the land is very near of the ſame Figure with the Sea (only raiſed a little higher that it might not be overflowed) compoſing with it the ſame ſolid, and I have already ſhewed that the Surface of the Ocean is ſpheroidical and not ſpherical, there is no doubt to be made but that the Land was formed into the ſame Figure by its wiſe Creator, at the beginning of the World, for if it were otherwiſe, then would the Land towards the Æquator have been overflowed with water, which as I have already proved, muſt have been higher at the Æquator than at the Poles; and therefore the Sea would riſe there and ſpread it ſelf like an inundation upon all the Land.

But for a further confirmation of the ſpheroidical Figure of the Earth let us conſider ſome of the other Planets eſpecially *Jupiter* who turns round his own Axis in the ſpace of ten hours: It may eaſily be obſerved that his Axis is conſiderably ſhorter than the Diameter of his Æquator, and that in the proportion of ſeven to eight, as the obſervations of Mr. *Flamſtead* and Monſ. *Caſini* do teſtify; and therefore we need not doubt but that the Earth which is a Planet like the reſt and turns round its Axis as they do, is of the ſame Figure.

But the Theoriſt in his Latin Edition of the Theory, as alſo in his Anſwer to Mr. *Warren*, ſeems to inſinuate, that the only way to find the true Figure of the Earth is by meaſuring of it, and by that means to find what proportion the degrees of the Meridian in different Latitudes have to one another; for if they were exactly equal one to another, and alſo equal to the degrees of Longitude counted upon the Æquator, then without doubt the Figure of the Earth would be Spherical, but if otherwiſe Spheroidical.

Now tho' I have already determined the Earths Figure from other Principles; Yet to comply with the Theoriſt in this point, I will give him an account of a Book whoſe extract I have ſeen in the *Acta Eruditorum Lipſiæ publicata* for the year 1691, written by one *Joh. Caſp Eiſenſchmidt a German* who calls himſelf Doctor of Philoſophy and Phyſick. The Title of the Book is, *Diatribe de Figura Telluris Elliptico-Sphæroide.* And it is Printed at *Strasburg* in the Year 1691. The Learned and deep-thinking Author of this Book after he has Anſwered, at leaſt has endeavoured to Anſwer the Arguments of *Archimedes* and others, by which the Figure of the Earth was proved to be Spherical, doth embrace the Opinion of the Theoriſt, and aſſerts that its Poles are higher or further diſtant from the Centre than its Æquator: To prove this, he ſets down an account of the different magnitudes of degrees of the Meridian according to the obſervations made of them in different Latitudes, and comparing them one with another, he found that they continually decreaſed as the Latitudes increaſed, and indeed, as he ſays in the ſame proportion, as appears by the following Table, which I have inſerted from the above named Extract.

Obſervers.	The Latitude of the Places obſerved.	The Magnitude of a Degree in Roman Miles.
Eratoſthenes.	27°	100
Ricciolus.	44½°	80
Monſ. Piccard.	49°	74
Fernellius.	49½°	73½
Snellius.	52°	71⅓

From this he concludes that a plane cutting the Earth along its Axis would not be a Circle but an Ellipſis, whoſe longer Axis would paſs through the Poles and coincide with the Axis of the Earth; but its leſſer Axis would be the common Section of the Æquator with the Ellipſis, and from thence he infers, that the Earth is not of a Spherical, but an oblong Spheroidical Figure. After that he diſputes againſt Mr. *Newtons* Hypotheſis, which makes the Earth of a direct contrary Figure, and thinks that the accurate Obſervations by him related, are by far to be preferred to the Hypotheſis upon which Mr. *Newtons* Calculus is grounded.

None but a man of prodigious ſtupidity and careleſneſs could reaſon at this rate! If he had aſſerted that the Earth was of an Oval Figure becauſe Graſs grows or Houſes ſtand upon it, it had been ſomething excuſable; for that Argument tho' it did not infer the concluſion, yet it could never have proved the contradictory to be true. But to bring an Argument which does evidently prove that the Earth has a Figure directly contrary to that which he would prove it has, is an intolerable and an unpardonable blunder; for if he had but protracted the Figure, and drawn equal Angles from the Centre, he might have eaſily perceived, that the Angle whoſe Crura were longeſt, would have the greateſt Subtenſe. Thus if the Angles [*Fig.* 8. *Plate* IV.] D A E and B AC were equal, but A D were longer than A B, it is evident that the ſubtenſe D E would be longer than the Subtenſe B C, for if you take A M and A N equal to A B and A C and draw the Line M N, the Angles being ſmall, B C and D E will differ very little from ſtreight Lines, but B C is equal to M N, which is plainly leſs than D E, and therefore it is evident that B C is leſs than D E, that is, where the Subtenſes or the degrees are greateſt, there alſo is the greateſt Diameter: but it is plain by the Obſervations which Mr. *Eiſenſchmidt* relates, that the degrees are biggeſt at the Æquator, therefore the greateſt Diameter of the

Plate IV.

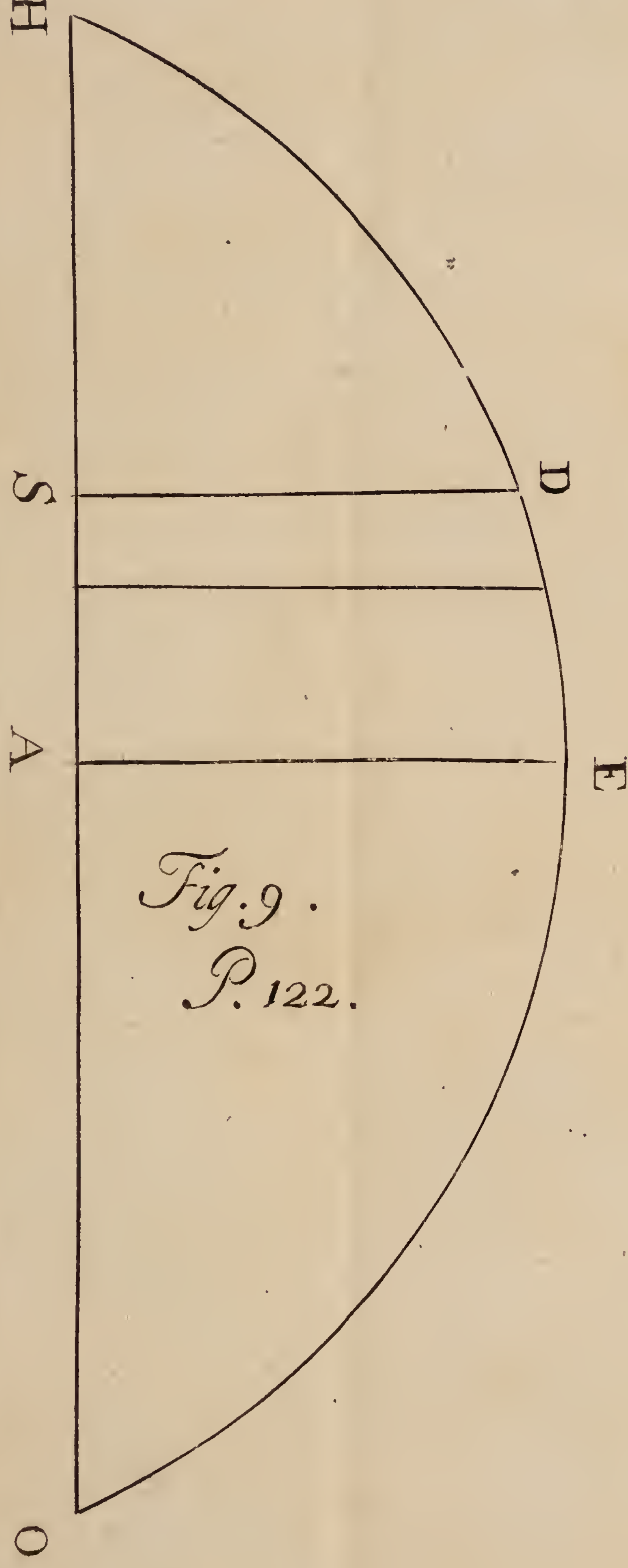
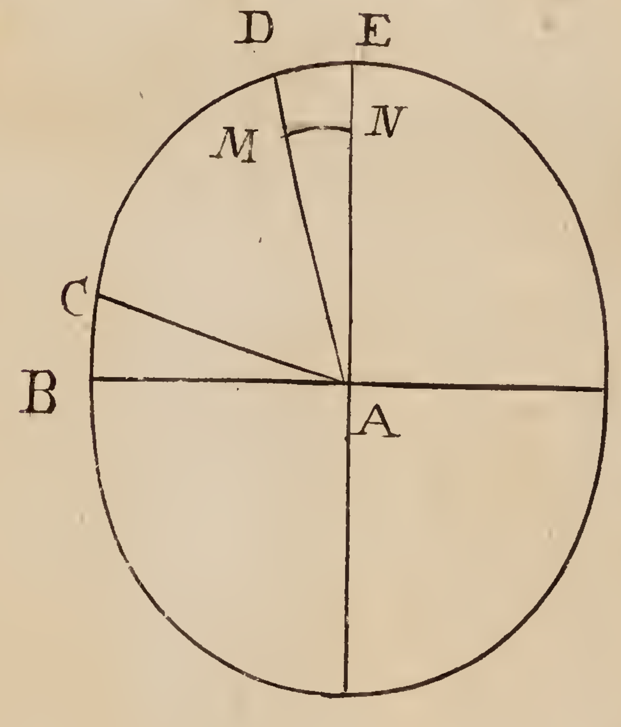


Fig. 9. P. 122.

Fig. 8. P. 112.



the Spheroid muſt be that of the Æquator, and not the Axis of the Earth.

So far is this Argument drawn from Obſervations from deſtroying Mr. *Newtons* Hypotheſis, that it would moſt evidently confirm it, if the Obſervations were exact enough, which I believe they are not.

I cannot but wonder at the ſtrange Logicks of our Modern Philoſophers who are able to draw any concluſion they have a mind for, from any Principles that can be given them. No man that looks narrowly into their Books can want Inſtances in this matter, But in caſe this is not ſo well obſerved, I have furniſhed the Reader with two examples of this ſort. The one is the Theoriſts way by which he proves the Earth to be of an Oblong or Oval Figure from the Principles of a Centrifugal force which all Bodies have that are on it. Now I think I have plainly ſhown that the true Concluſion he ought to have inferred from this Hypotheſis is, that the Earth had a quite contrary Figure from what he fancied it had. But Mr. *Eiſenchmidt* has given us a yet plainer proof of this thing, for becauſe he found that the Degrees of Latitude near the æquator were bigger than thoſe which were near the Pole, he very innocently concludes that the Earth had its Axis longer than the Diameter of its Æquator; but if he had underſtood the firſt ſix Elements of *Euclid*, or indeed thoſe of common ſenſe he might eaſily have demonſtrated the contrary: it is ſtrange that when there is but one Right and one Wrong Opinion in this Point, that he ſhould be ſo unlucky as to hit upon the falſe one to maintain it.

Chap. VII.

Of the Diſſolution of the Primitive Earth.

HITHERTO I have refuted the Theoriſts Motion, Poſition, and Figure, of the Primitive Earth. I am now to conſider his method of Diſſolving the Fabrick he has raiſed, and to Examin how and by what cauſes, the firſt Earth which had all the Beauty of Youth and Blooming Nature, Freſh and Fruitful, and not a Wrinkle or Scar on all its Body, came to be diſſolved; how the Fabrick was broke, and the Frame of the whole torn in pieces, how it came to be a ſhattered and confuſed heap of Bodies, as we now ſee it, placed in no order one to another, nor with any correſpondency or regularity of parts, as the Theoriſt repreſents it to be.

He tells us that one would ſoon imagin that ſuch a ſtructure as that of the firſt Earth was, would not be perpetual nor laſt many thouſands of years, if one conſider the effect, the heat of the Sun would have upon it, and the Waters under it, drying and parching the one, and rarifying the other into vapours: For according to him, the courſe of the Sun was ſuch at that time, that there was no diverſity or alteration of Seaſons in the year, as there is now; by reaſon of which alteration of Seaſons, our Earth is kept in an equality of temper, the contrary Seaſons ballancing one another; ſo that what moiſture the heat of the Summer ſucks out of the Earth, is repaired again in Rains the next Winter, and what chaps are made in it are filled up, and the Earth is reduced to its former conſtitution. But if we ſhould imagin a continual Summer the Earth would proceed in dryneſs ſtill more and more, and the cracks would be wider and pierce deeper into the ſubſtance of it. The heat of the Sun therefore according to the Theoriſt, acting continually upon the Earth, would have reduced it in the ſpace of ſome hundreds of years to a conſiderable degree of dryneſs, in certain parts, and would alſo have much rarified and exhaled the water under it; ſo that conſidering the ſtructure of that Globe, the exterior Cruſt, and the Water under it, he thinks it may be fitly compared to an Æolipile or an hollow Sphere, with Water in it, which the heat of the fire rarifies and turns into Vapour or Wind; the Sun here is the Fire, and the exterior Earth the ſhell of the Æolipile, and the Abyſs the water within it; as ſoon then as the heat of the Sun had reached the waters in the Abyſs it began to rarify them, and raiſe them into Vapours, by which rarifaction they required more room, than they did before, and finding themſelves pent in by the exteriór earth they preſſed with violence againſt that Arch to make it yield and give way to their dilatation: and by this means the Earth was broken, and the frame of it torn in pieces as by an Earthquake, and thoſe great portions or fragments into which it was divided, fell down into the Abyſs, ſome in one poſture and ſome in another, and was the cauſe of a general Deluge. I ſhall now examin theſe cauſes which the Theoriſt has given for the Diſſolution of the Earth, and in this Chapter I will firſt enquire whether the heat of the Sun can reach ſo far as the great Abyſs to rarify the waters thereof.

Firſt then I have proved in the third Chapter of this examination, that there were Hills and Mountains in the primitive Earth as there are now in ours. I have alſo ſhown that the Axis of the earth was then enclined the ſame way to the Plane of the Ecliptick as it is at preſent; from thence it plainly follows that there was then, the ſame variety of Seaſons and Alterations of Heat and Cold in the primitive earth, that there are now in our earth, and by conſequence, all the Arguments drawn from the great heat and ſtrong action of the Sun upon the Antediluvian earth muſt fall to the ground, there being then no greater heat of the Sun on the earth than there is at preſent.

But 2*dly*, there are places in the earth, as the Iſland of *Barbadoes* and ſome other Iſlands near the Æquator, where there is little or no variety of Seaſons or alteration of the Suns heat, but it continues to ſhine very ſtrongly upon them throughout the whole year, and yet in none of them is there any of theſe great Chaps and Cracks which the Theoriſt ſays were made in the primitive earth by the ſtrong action of the Sun; tho' it has ſhon above thrice as long upon theſe Iſlands as it did upon the Antediluvian World.

3*dly*, It is certain that if we judge according to experience that the heat of the Sun doth not reach far into the Earth, and that its beams can go but a very little way into the Cruſt; for in Vaults and Caves there is no ſenſible alteration of heat in Summer and Winter, even tho' they have a communication with the open Air, And in the deep pits of the Royal Obſervatory at *Paris* it has been found by experience, that a Thermometer placed there, in the coldeſt day of Winter does not ſenſibly vary from what it was in the greateſt heat in Summer; and they who work in Mines can tell how little difference they obſerve of heat in the Summer, more than in the Winter, in places underground. But if the heat of the Sun could penetrate for any conſiderable depth the Cruſt of the Earth, it is plain, that when its heat is ſtrongeſt and moſt intenſe upon the Surface, it would alſo be moſt intenſe within the Cruſt; but the forementioned experiments do prove that within the bowels of the Earth there is no ſenſible difference between the heat of the Sun when its action is ſtrongeſt, from what it is when its action is weakeſt. Since then the heat of the Sun does not penetrate the Earth ſo as to be ſenſible even for the ſmall ſpace that we are able to dig thorough, how can we imagin it poſſible that it ſhould ever reach the Abyſs through the whole exterior Cruſt of the Earth ſo as to be able to heat the water and raiſe it into Vapour?

But that I may bring this point to a Calculation as near as I can, I will ſuppoſe that the heat cauſed by the direct influence of the Sun upon any Surface is always (all other things being the ſame) as the quantity of Rays of heat which falls upon that Surface; which I believe the Theoriſt will allow: I will alſo ſuppoſe that fewer Rays of heat paſſed thorough the ſolid Orb than if it had been compoſed of ſeveral concentrical Surfaces placed at ſome diſtance from one another, every one of which tranſmitted only the one half of the Rays of heat which fell upon it: this I think may be alſo eaſily allowed; for it is plain, that the Surface of the Earth does not tranſmit the half, nay not the hundredth part of the Suns beams which fall upon it. Theſe things being ſuppoſed, it is plain that but one half of the Rays which fall upon the firſt Surface, would fall upon the ſecond, but one fourth of them upon the third, one eighth part of them upon the fourth, and one ſixteenth part upon the fifth, *&c.* ſo that they would ſtill decreaſe in a Geometrical proportion of 2 to 1; and if there were but one hundred of theſe Surfaces, the number of Rays which fell upon the firſt would be to the number of Rays which paſſed thorough to the laſt as 2^{99} to 1, or as the ninty ninth power of 2 is to 1. How great a diſproportion then would there be between the number of thoſe Rays which fell upon the firſt ſurface and thoſe which fell upon the laſt? for the ninty ninth power of 2 is a number which if written at length would conſiſt of a hundred Figures: but if we ſhould imagin all the ſpaces between the Surfaces filled up with ſolid and not diaphanous matter as it really is ſo in the Cruſt of the Earth, the heat upon the ſurface muſt be much leſs than what it would be by the former proportion.

From thence we may conclude that if the heat of the Sun upon the Surface of the Antediluvian Earth was not much greater than it is now, it could never reach ſo far into the Cruſt as to be able to raiſe Vapours from the Abyſs: or if it was ſo great as to be able to raiſe Vapours from thence, that is, if it was then as great upon the Surface of the Abyſs as it is generally upon the Surface of the preſent Earth, it muſt have been almoſt infinitely greater upon the Surface of the Antediluvian World. Certainly there could be no neceſſity for a Deluge in that caſe, except it were to cool the Earth again after ſuch an exceſſive heat, which muſt have deſtroyed all the Animals, Plants, and Trees which were upon the earth, and have turned them into Glaſs.

But perhaps it may be urged that the heat of the Sun does generate and prepare Metals which lie hid in its bowels; To which I anſwer, that I have already brought a ſufficient demonſtration that the heat of the Sun does paſs but a very little way within the earth, and therefore the Opinion that Metals are generated by the Suns influence muſt be falſe; for they generally lie far hid within the bowels of the earth, and therefore without the reach of the Suns influence.

But the Theoriſt affirms further, that there was a continual Summer in the Antediluvian earth, and therefore if the heat of the Sun made a crack in the earth in one year, there being no Winter or Rains to repair the chaps that were made in the earth, this crack would continually grow deeper, till at laſt it would reach to the Surface of the Abyſs. Let us now bring this general way of ſpeaking to a Calculation, and try if the heat of the Sun could this way reach the Abyſs. To determin which, I will ſuppoſe that through length of time, the Sun has made a crack in the earth of a Miles depth and one hundred foot in length extended from *Eaſt* to *Weſt*, and let it be propoſed to Calculate what proportion the heat upon any point of the Surface bears to the heat upon the bottom of the crack. In the Figure [*Fig.* 1. *Plate* I.] let P S A Q repreſent the Æquator in which the Sun moves, P R T the Earth, P Q the ſenſible Horizon, and P *n m* R the Pit made by the heat of the Sun in the Cruſt of the Earth: it is plain that the Sun ſhines on the point R on the Surface of the Earth all the time it is moving through the Arch P Q, but it ſhines only on the point *m* in the bottom of the Crack while it deſcribes by its motion the Arch S A. Now the Action of the Sun upon any point is always more or leſs ſtrong in proportion to the ſine of the Angle of incidence of its Rays, that is, if the Sun be at S, and afterwards come to A, the action of the Sun upon the point R when it is at S, is to its action when it comes to A, as the ſine of the Angle S R P is to the ſine of the Angle A R P. From whence it follows, that the action of the Sun upon the point R is to its action upon the point *m*, as the ſum of all the ſines of the Suns Altitude while it ſhines upon R is to the ſumm of all the ſines of the Suns Altitude while it ſhines upon the point *m*, that is if the times it ſhines upon R and *m* be taken for Baſis's or the Arches P Q and S A which are proportional to them, be extended into ſtreight lines H S A O, [*Fig.* 9. *Plate* VI.] and S A, and all the ſines be erected on them perpendicularly, A E being the Sine of the Arch A H and S D the ſine of the Arch S H, and the Curve line H D E O be drawn thorough the extremity of the ſines, the heat upon the point R is to the heat upon the point *m*, as the ſpace H D E O is to the ſpace S D E A, But the Periphery P S A Q being a ſemicircle (for the Diameter of the Earth is but a point in reſpect of the Suns diſtance from us) It is plain that the ſpace H D E O is two figures of ſines, which the Mathematicians have demonſtrated to be equal to two ſquares of the Radius; and it is alſo by them demonſtrated that the ſpace S D E A is equal to a rectangle contained by the Radius and the ſine of the Arch S A; but as I have already ſhewed the heat of the Sun upon the point R is to its heat upon the point *m* as the ſpace H D E O is to the ſpace D S A E. It is plain from thence, that the heat or action of the Sun upon the point R is to its action upon the point *m* as two ſquares of the Radius is to a rectangle contained by the Radius and the ſine of the Arch S A, that is, as twice the Radius is to the ſine of the Arch S A, by the firſt of the *6th* of *Euclid:* But becauſe P *n* is to P R as 5000 is to an 100, or as 50 to 1, therefore by a trigonometrical Calculation the ſine of the Angle S *m* A, or of the Arch S A is 19594 ſuppoſing the Radius a 100000, the heat therefore upon the point R is to the heat of the Sun upon the point *m*, as 200000 is to 19594, and conſequently the one is more than decuple of the other. If therefore the heat upon the bottom of the Crack was ſo great as to reach further into the Cruſt, it muſt have been at leaſt ten times greater upon the ſurface of the Earth; and if the heat of the Sun upon the bottom of the Crack was as great as is neceſſary for to raiſe the waters in the Abyſs into Vapours, or as great as our Summers heat is, the heat upon the ſurface of the Earth muſt have exceeded the heat of red hot Iron, which is only ſeven times greater than the ordinary heat of the Sun in Summer.

But notwithſtanding all this, ſhould I grant to the Theoriſt that the heat of the Sun had reached the Abyſs, and had raiſed the Vapours ſo that the cruſt of the Earth fell down and was broken in pieces, yet I cannot ſee how from thence there could follow any univerſal Deluge, or indeed any Deluge at all, tho' the Theoriſt does endeavour to explain it thus.

When the Earth ſays he, was broken and fell into the Abyſs, a good part of it was covered with water by the mere depth of the Abyſs it fell into; and thoſe parts of it that were higher than the Abyſs was deep, and conſequently would ſtand above it in a calm water, were notwithſtanding reached and overtopp'd by the waters during the agitation and violent commotion of the Abyſs; for it is not imaginable ſays he, what the commotion of the Abyſs would be upon this diſſolution of the Earth, nor to what height its waves would be thrown when theſe prodigious fragments were tumbled down into it. If you would ſuppoſe a ſtone of ten thouſand weight taken up into the Air, a Mile or two, and then let fall into the middle of the Ocean, it is Credible that the daſhing of the water upon that impreſſion would riſe as high as a Mountain; but if you will ſuppoſe a mighty Rock, or a heap of Rocks to fall from that height, or a great Iſland or Continent, theſe would expel the waters out of their places with ſuch a force and violence as would fling them above the higheſt Clouds.

This is in ſhort, the method the Theoriſt has found out for making an univerſal Deluge. But if I can prove from his own Principles, that long before the Deluge happened, all the Waters in the Abyſs were drawn up by the heat of the Sun to ſupply the Rivers that were neceſſary to water the Earth, I would fain know what would become of his Deluge, or how he can make in that caſe the fall of the Cruſt to be the cauſe of an Univerſal Flood: for by all the conception that I can have of it, the water which was upon the ſurface of the Earth, by the fall would ruſh into the Abyſs; and it would be ſo far from making any Flood, that it would leave the ſurface of the Earth and make dry Land appear where formerly there was none. To prove this I muſt firſt enquire what proportion the quantity of waters which the Sea receives from the Rivers of the Earth in any time bears to the quantity of water in the Ocean; and by conſequence I will Calculate the time the Rivers would take to fill the Ocean if it were empty, and they ran as they do now, or which is the ſame thing, I will find what time the Sea would take to empty it ſelf into the Rivers ſuppoſing that it was not recruited again by the continual courſe of freſh waters, which run into it, that is, if the Abyſs did formerly ſupply all the Rivers with water, before the flood, and none of them ran into it again, as the Theoriſt ſuppoſes they did not, I am to find what time it would take to empty it ſelf, on the ſurface of the Earth. And if I can prove that it would quite empty it ſelf on the ſurface, long before the Deluge happened, I think from thence it would neceſſarily follow that there would be no Deluge at all, by the fall of the Cruſt.

To begin therefore, I will ſuppoſe as the Theoriſt has done, in his ſecond Chap. Book firſt, that one half of the ſurface of the *Terraqueous* Globe is Sea, and the other Land, and that if we take the Sea one place with another, it is a quarter of a mile deep. Now the ſurface of the whole Earth being 170981012 *Italian* miles, the ſurface of the Sea is 85490506 ſquare miles, which being multiplied by $\frac{1}{4}$*th* (the Sea being $\frac{1}{4}$*th* of a mile deep) the product is 21372626$\frac{1}{2}$ Cubical miles, which is the quantity of water contained in the whole Ocean.

Now to Calculate the water the Ocean receives from the Rivers, we muſt conſider ſome great river whoſe breadth depth and ſwiftneſs are beſt known, ſuch is the *Po* which paſſes through *Lombardy* and waters a large Country of 380 miles in Length: *Ricciolus* in his *Geographia Reformata* tells us, that its breadth before its diviſion into a great many Channels, by which it falls into the Sea, is a hundred *Bononian* Perches, or a thouſand feet, and its depth is one Perch or ten Feet, and therefore its perpendicular Section, from one ſide to the other is a hundred ſquare Perches, or 40000 ſquare Feet: Its ſwiftneſs alſo is ſo great, that the courſe of the water is about four *Italian* miles in an hour, or which is the ſame thing 2000 *Italian* Perches, for there are 500 Perches in a mile; The *Po* therefore carries into the *Adriatick* 200000 Cubical Perches of water, in the ſpace of an hour, and therefore the quantity of water it brings into the Sea in a day is 4800000 Cubical Perches or 380000000 Cubical Feet of water; but one Cubical mile contains 125000000 Cubical Perches, and therefore if the *Po* takes one day, to bring into the *Adriatick* 4800000 Cubical Perches of water, it will require twenty ſix days, to carry into the Sea 125000000 Cubical Perches, or one Cubical mile, or which comes to the ſame thing, twenty ſix Rivers every one of which is of the ſame ſwiftneſs with the *Po* will pour into the Sea one Cubical mile of water in a day.

I muſt in the next place determin what proportion all the Rivers in the Earth bear to the *Po*, which to determin exactly would be a task, not eaſily to be performed; but I think we may determin it near enough for our preſent purpoſe, by ſuppoſing that the quantity of water received into the Sea, by the great Rivers in any Country, is very near proportional to the extent and ſurface of that Country; And conſequently the Country which is watered by the *Po*, and the Rivers which run into it, bears the ſame proportion to the ſurface of the whole dry Land, that the *Po* doth to all the Rivers in the Earth:

But I have obſerved from the exacteſt Maps I could ſee, that the *Po* from its Origin in the *Alps*, to its end where it runs into the Sea, is in length three hundred and eighty miles, and that the Rivers which fall into it from each ſide, come from Springs of about ſixty miles diſtance from the *Po*; conſequently the *Po* and the Rivers which run into it, water a Country which is 380 miles long, and 120 broad, all which makes 45600 ſquare miles; but the ſurface of all the Land being equal to half the *Terraqueous* Globe is 85490506 ſquare miles, and therefore according to the proportion formerly mentioned, the water which is carried into the Sea by all the Rivers, is 1874 times greater than what the *Po* carries into the Sea.

It is true, there are in the Earth ſome barren places which have no great quantity of water or Rivers in them, but they being but ſmall will not much alter our account, and for an Equivalent, we can eaſily prove, that tho' there are ſome Countries not ſo well ſtored with Rivers as *Lombardy*, yet there are ſeveral others which are much better furniſhed with them, particularly the *South* part of *America*, where there are Rivers, which according to credible relations are above fourſcore miles in breadth, and therefore by allowing a proportional depth, they will be ſeveral hundreds of times bigger than the *Po*.

Now I have already Calculated, that twenty ſix *Po's* will pour into the Sea one Cubical mile of water in a day; and conſequently in 365 days, or in the ſpace of a year they will pour into the Sea 365 Cubical miles of water: hence it follows, that if 26 Rivers as big as the *Po*, pour into the Sea 365 miles of water, in the ſpace of a year, from 1874 Rivers as big as the *Po*, there will be brought into the Sea in the ſame time 26308 Cubical miles of water; and therefore by the rule of proportionals, in the ſpace of 812 years, the Rivers will bring into the Sea 21372626 Cubical miles of water, which is a quantity of water as great as the Ocean: and therefore in that time they would fill the great Channel of the Ocean if it were empty, and their courſe the ſame, both for quantity of water, and ſwiftneſs that it is now: And ſince the Sea furniſhes the Rivers with all the water that runs through them, it is plain that the Sea would empty it ſelf in the ſpace of 812 years if none of the Rivers ran into it again.

Since therefore according to the Theoriſt, the Abyſs was the ſtore-houſe which furniſhed the Rivers of the Antediluvian Earth with water, and none of them, according to him, ran into it again, and becauſe all the waters which were antiently in the Abyſs, are now in the Ocean, it muſt needs follow, that in the ſpace of 812 years it would be quite empty, upon ſuppoſition that there were as many Rivers in the primitive Earth as there are now in ours; but becauſe there was then twice as much Land to be furniſhed with Rivers (there being then no Seas as the Theoriſt ſays) we muſt in proportion allow twice as many Rivers to water the double quantity of dry Land, and therefore by ſuch a double quantity of Rivers, the Abyſs would be emptied in half that time.

Perhaps the Theoriſt will ſay, that the Rivers were not altogether furniſhed by Vapours drawn from the Abyſs, but by thoſe alſo that were exhaled from the ſurface of the Earth, and that after the water in the Rivers had run towards the Æquator and middle parts of the Earth, the water was again raiſed into Vapours by the great heat of the Sun, and carried back towards the Poles in order to ſupply the Rivers again. But this is no objection to our preſent Argument, for tho' the Vapours drawn from the ſurface of the Earth, would no doubt encreaſe the quantity of water, in the Rivers, yet ſtill there would be drawn from the Abyſs, the ſame quantity of Vapour as was before; the ſame cauſe ſtill continuing to act, would ſtill produce the ſame effect, and the Abyſs having at firſt furniſhed the Rivers with a ſufficient quantity of water, would ſtill continue to do the ſame, and in the ſame quantity; and therefore it ſignifies nothing againſt the former Calculation, how much Vapour was drawn from the ſurface of the Earth, or how much the Rivers were encreaſed by it.

Since then I have ſufficiently proved on the ſuppoſition of his Principles, that all the water, in the Abyſs was long before the time of the Deluge, drawn out of the Abyſs, and placed on the ſurface of the Earth; I would fain know how in that caſe the Theoriſt can explain an Univerſal Deluge by the fall of the outward Cruſt of the Earth upon the Abyſs: for in my Opinion, this fall would have been ſo far from being the cauſe of a Deluge, that it would have proved the true way to deliver the Earth from a Deluge of waters which was then on it. For all the water which was in the Abyſs, being drawn up on the ſurface of the Land, and the Earth being of a Spheroidical and Oval ſhape, without Hills and Mountains, upper and lower Grounds, but exactly of the ſame Figure which its gravity and centrifugal force formed it into, when it was fluid; the great Maſs of water which was then upon the Earth muſt have ſettled it ſelf alſo in the ſame Figure, it having no banks to retain it within its Channel, or Mountains to keep it within bounds; and the true effect of the fall of the Cruſt, muſt have been to have diſcovered the Land, and the waters would have run from the ſurface of the Earth into the Abyſs, and there would have formed a Sea, and made that Land appear which before was covered with waters.

Notwithſtanding what I have already proved, I will now ſuppoſe, that all the water which is now in the Ocean, was in the Abyſs at the time of the Deluge, and that the Cruſt of the Earth was broken and crackt, and fell down on the ſurface of the Abyſs; yet ſtill I cannot underſtand how this fall could produce an Univerſal Deluge, and make the waters ſwell above the tops of the higheſt Mountains. For the Theoriſt has Calculated, that it would at leaſt require eight Oceans of water to cover the face of the whole Earth, and raiſe the waters to a height that would be requiſite for drowning of the world. Now there being but one Ocean of water in the Abyſs, how is it poſſible that any however violent agitation and force by which the waters were driven upwards, ſhould multiply this one Ocean of waters into eight Oceans? this I am ſure is a thing as impoſſible for him to explain as it is for me to believe: it is plain indeed that the fall of the Cruſt eſpecially if there were any conſiderable diſtance between the Abyſs and it, would raiſe the waters to the tops of the higheſt Mountains, and would in ſome places produce a partial Deluge; but it is evident, that it is impoſſible in nature, let the motion be never ſo violent, that one Ocean ſhould be ſufficient to cover the whole Earth, and that above the tops of the higheſt Mountains, when eight Oceans are the leaſt that can be required to perform ſuch an effect. The waters indeed at different times, might have covered the whole Earth ſucceſſively; firſt by making a Deluge in one place and then in another, but this could never have been brought to paſs by the fall of the Cruſt at once. Beſides the Scriptures inform us that the whole Earth was under water at the ſame time, and that *all the high Hills, that were under the whole Heaven, were covered:* now it is as impoſſible that one Ocean ſhould ſuffice to drown the whole Earth, and cover the tops of the higheſt Hills, tho' for the ſpace of one moment, as it is to make one pint of pure water fill a veſſel which holds a Gallon. This Argument which I have now uſed is the Theoriſts own, which he has alledged in his 2*d* and 3*d* Chapters againſt all other ways of deſtroying the Earth by a Deluge; but he did not then obſerve, that it concluded as ſtrongly againſt his own Theory, as it did againſt any other which pretends to explain the Deluge without the ſuppoſition of more water than what was Lodged in the Ocean or the Clouds.

But tho' I ſhould ſuppoſe that there was ſufficient water in the Abyſs to cover the face of the whole Earth at once, yet I cannot conceive how ſuch a flood of waters that was raiſed by the fall of the Cruſt, could laſt for ſo long a time, as the Scriptures inform us *Noah*'s flood did, which was an hundred and fifty days without abating on the face of the Earth. We know that water driven with great violence upwards falls down again in a very ſhort ſpace of time; and can we Imagin that the water which was raiſed by the fall of the Cruſt, could laſt many days, or indeed many hours without deſcending again to its ancient Channel? But the Scriptures aſſure us that the water in *Noah's* Flood continually encreaſed, and prevailed on the Earth for the ſpace of one hundred and fifty days; it is plain therefore, that for this very reaſon the Flood of *Noah* could never be produced by the fall of this outward Cruſt of the Earth.

The Concluſion.

THERE are two ſort of Arguments that may be brought againſt the Theory, the one depends only on the principles of Reaſon and Philoſophy, and the other on the Authority of the writings of *Moſes*: but theſe which might be gathered from *Moſes* would be of no force againſt the Theoriſt; * ſince he denies the truth of his narrations, which he imagines to be invented by that excellent Law-giver to pleaſe and amuſe the Jews: I have therefore in this Treatiſe only made uſe of Arguments which are drawn from Philoſophy, which he cannot

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* *Archæologeæ Philoſoph. p.* 320. 321.

not refuſe to admit ſince he appeals to them, for the Truth of his own Hypotheſis.

Becauſe the Theoriſt tells us, that all things were made according to the three Mathematical ſciences of Arithmetick, Staticks and Geometry, and that to underſtand the manner of their compoſition, we muſt proceed in the ſearch of them by the ſame Principles, and reſolve them into theſe again; I thought therefore I might fairly examin his Theory by the rules of thoſe three Mathematical Sciences; and I hope that I have ſhown, that it is built on principles which are directly repugnant to each of them: But becauſe Arguments drawn from the Mathematicks are not eaſily underſtood by thoſe that are unacquainted with that Science, I have endeavoured to chooſe only thoſe Arguments which are plain and obvious and which depend only on Arithmetick and the common principles of Hydroſtaticks; ſo that except in one or two places, there is nothing in this Treatiſe but what may be eaſily underſtood by thoſe who have a moderate knowledge in theſe Sciences.

The points I have examined according to theſe rules are, Firſt, the Origination of the Earth from a Chaos, which as it is delivered down to us by *Moſes*, muſt be undoubtedly owned by thoſe who acknowledge the Divine Inſpiration of that Writer; But as the Theoriſts method of forming the World is not agreeable to the *Moſaick* Hiſtory; ſo I think I have ſhewed that it is repugnant alſo to the Laws of Nature and Gravitation, which by his method could never have produced any habitable World.

2dly, The form of the Antediluvian World, which the Theoriſt ſays, was ſmooth, regular, and uniform, without mountains and without a Sea. This he aſſerts to be a neceſſary conſequence of its riſe from a Chaos; but I have proved that it is not ſo neceſſary, that an Earth ariſing from a Chaos, ſhould be uniform and ſmooth as he ſuppoſes. I have alſo ſhewed the great uſe of Mountains, and how neceſſary they are for our ſubſiſtance in the preſent Earth, and that they are ſo far from being placed here without deſign, as the Theoriſt imagins, that there is ſcarce any thing in nature that ſhews more of wiſdom and contrivance than they do, being abſolutely neceſſary for the furniſhing and maintaining Rivers with freſh waters; which is a demonſtration that they were in the primitive Earth as well as they are in ours.

3dly, The right poſition of the Earths Axis, which I have proved to be ſo far from being excellent and fitted for a Paradiſiacal World, that it would make the greateſt part of the Earth not habitable. I have alſo enquired into the great advantages we reap from the preſent poſition of the Earths Axis, which is by far preferable to any other, eſpecially to the perpendicular poſition of the Axis of the Earth to the plane of the Ecliptick.

4thly, The method the Theoriſt has found out to form the Antediluvian Rivers when there was no Sea to furniſh them with waters, or any Channel or Ocean to receive them. This I have proved to be impoſſible on ſeveral accounts ſince the heat of the Sun could never bring up ſo much Vapour from the Abyſs, as would be neceſſary to furniſh all the Rivers of the Earth with water; and tho' we ſhould grant that Vapours were drawn from the Abyſs in places near the Equinoctial as he ſuppoſes, yet it is impoſſible that they ſhould ever reach the Poles, there to form the Springs from which the Rivers were to run; Or if Vapours were once brought to the Poles by whatever cauſe we can imagin, yet it is impoſſible that they ſhould ever run back from the Poles to the Æquator; ſince according to him the Earth was perfectly ſmooth and uniform without any upper grounds from whence the water was to deſcend to the lower places of the Earth.

5thly, The Figure of the Earth which the Theoriſt rightly affirms not to have been exactly Spherical, becauſe at the Commencement of the Diurnal rotation, it being Fluid all the parts of it would endeavour to recede from the Axis of their motion: but as he has gueſſed that it did ſettle into an Oblong

long Spheroidical or Oval Figure, on no other account, that I know of, but becauſe he thinks ſuch a one would beſt anſwer his deſign, ſo I think I have clearly enough demonſtrated, that the Earth has formed it ſelf into a quite contrary Figure, whoſe Axis is ſhorter than the Diameter of the Æquator; and I have proved from Obſervations, that the Earth is really of ſuch a Figure.

6thly, The cauſes the Theoriſt has aſſigned for the breaking of the outward Cruſt which he affirms to be done by the great heat of the Sun. But this I have clearly proved to be a cauſe altogether inſufficient for ſuch an effect, ſince the heat of the Sun could never reach ſo far into ſo thick a Cruſt as to be great enough to raiſe water into Vapours. But laſtly, granting the Cruſt to have been broken, and to have fallen down into the Abyſs, yet I have proved from the Theoriſts own Principles, that there could follow no Univerſal Deluge, there being not ſo much water in the Abyſs as was ſufficient to cover the face of the whole Earth.

Throughout the whole Examination, I have obſerved the Theoriſts advice, and have conſidered only the ſubſtance of the Theory without making any excurſions upon things that are accidental and collateral, which as he ſays do not deſtroy his Hypotheſis. Theſe are the main foundations on which his Theory is built, and ſince I have proved them all to be not only precarious, but impoſſible, his whole Hypotheſis muſt fall with them. Perhaps many of his Readers will be ſorry to be undeceived, for as I believe, never any Book was fuller of Errors and Miſtakes in Philoſophy, ſo none ever abounded with more beautiful Scenes and ſurpriſing Images of Nature; but I write only to thoſe who might perhaps expect to find a true Philoſophy in it. They who read it as an Ingenious Romance will ſtill be pleaſed with their Entertainment.

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SOME

REMARKS

ON

Mr. WHISTON'S

Theory of the Earth.

THO' I think it impoſſible to give a True and Mechanical account, of that great Deluge of waters which once overflowed the Face of the whole Earth, it being a work not to be performed without the extraordinary contrivance of the Divine power; yet I cannot but acknowledge that Mr. *Whiſton* the Ingenious Author of this new *Theory of the Earth*, has made greater diſcoveries and proceeded on more Philoſophical Principles than all the Theoriſts before him have done. In his Theory there are ſome very ſtrange coincidents which make it indeed probable, that a Comet at the time of the Deluge paſſed by the Earth. It is ſurprizing to obſerve the exact correſpondence between the *Lunar* and *Solar* year, upon the ſuppoſition of a circular Orbit, in which the Earth moved before the Deluge. It cannot but raiſe admiration in us, when we conſider that the Earth at the time of the Deluge was in its *Perihelion*, which would be the neceſſary effect of a Comet that paſſed by at that time, in drawing it from a Circular to an Elliptical Orbit. This together with the conſideration that the Moon was exactly in ſuch a place of its Orbit at that time, as equally attracted with the Earth, when the Comet paſſed by, ſeems to be a very convincing Argument that a Comet really came very near, and paſſed by the Earth, on the day the Deluge began.

But notwithſtanding this, I believe it will be evident by the following conſiderations, that a Comet could never have produced thoſe various effects that Mr. *Whiſton* has attributed to it; and it will alſo further appear that the Deluge was the immediate work of the Divine power, and that no ſecondary cauſes without the interpoſition of Omnipotence, could have brought ſuch an effect to paſs. But firſt I will make ſome Remarks on the Origin of the Primitive Earth, and method by which Mr. *Whiſton* ſuppoſes it was formed.

Mr. *Whiſton*'s firſt Hypotheſis is, that the antient Chaos, the Origin of our Earth was the Atmoſphere of a Comet; but this ſuppoſition, tho' he endeavours to prove it by ſeveral Arguments, doth not ſeem probable for the reaſons following. Firſt the Scriptures repreſent the Primitive Antient Chaos as a very dark and obſcure Body; for they ſay, that it *was without form, and Void, and that Darkneſs was upon the face of the Deep:* this will further appear by the next verſe, where God is ſaid to have made light upon the firſt day of the Creation, which is a clear proof that there was none before that time, but that the whole Chaos was originally a dark and confuſed heap of Bodies. Now it is certain, by the Teſtimonies of all thoſe who have made any Obſervations about Comets, that their Atmoſpheres are very bright and luminous Fluids through which the beams of the Sun diffuſe themſelves very freely, and many of them are again reflected back to us: and indeed, if we conſider their pellucidneſs, and the vaſt quantity of Light which paſſes through them, without reflection, it is not eaſy to imagine how they ſhould appear ſo lucid to our Eyes. Nor do I believe that it is poſſible to find among all the pellucid Bodies of our Earth any one, which being placed at the ſame diſtance from us, as the Atmoſphere of Comets are, would appear ſo bright, or reflect the light ſo ſtrongly as they do. For it is eaſy to be obſerved, that diaphanous Bodies are not ſo luminous, nor do they reflect light in ſuch a quantity as it is reflected from opake Bodies. It cannot be ſaid that the light by which we perceive a Comet, is only reflected from the top of its Atmoſphere, and that it doth not paſs through the Body of it to illuminate all the other parts of it, which are therefore involved in thick darkneſs; for it is evident that light paſſes clearly through the whole Body of the Atmoſphere, and illuminates the central ſolid, which ſtrongly reflects the light to us back again.

I know Mr. *Whiſton* ſuppoſes, that this great darkneſs mentioned in the Scripture, proceeded from the ſubſiding of the vaſt Denſe and heavy Fluid, or large Abyſs, which he ſays encompaſſed the central ſolid, and was it ſelf covered over with a collection of Earthly, Watery, and Airy particles, intercepting and reflecting all the Rays of light which fell upon it: but this I think doth not well agree with the tenour of Scripture, which repreſents the Chaos in its very Original ſtate, as involved with darkneſs and obſcurity. It is alſo repugnant to all the ancient Traditions we have about it, which repreſent it as a dark and confuſed heap of Bodies, from the very beginning of its exiſtence, till the time of the Creation or Formation of the Earth. It is plain alſo that the

Abyſs or Deep mentioned in Scripture, could not be that denſe and heavy fluid Mr. *Whiſton* ſpeaks of, on which he ſays the upper Cruſt of our Earth is founded; it being certain, that the Scriptures are to be underſtood of an Abyſs which was then dark, and afterwards when light was created, was illuminated and made viſible. For when light is ſaid to have been made, without doubt we muſt ſuppoſe, that it was produced in ſome place which before was involved in darkneſs, and then expoſed to the light, which can never agree with Mr. *Whiſton*'s Abyſs, which he makes to be encompaſſed with a denſe and opake Cruſt perfectly impenetrable by the light of the Sun. It appears therefore, that this darkneſs mentioned in the Scriptures muſt be underſtood to be ſomewhere elſe than on the Surface of a denſe and heavy fluid that ſurrounds the central ſolid.

It is alſo to be obſerved, that it is not eaſy to conceive how theſe Earthy, Watery, and Airy particles, ſhould fall ſo thick and faſt on one another, as would be ſufficient to intercept all the light which fell upon them, and quite darken the Atmoſphere, without ſuffering the leaſt glimmering of light to paſs through them. For as Mr. *Whiſton* obſerves, the heat of a Comet when it paſſes its *Perihelion* is ſo exceſſively great, as to laſt many thouſand years; and we cannot doubt but that great commotion and confuſion which is raiſed by this heat muſt laſt proportionally, and as the heat doth gradually decreaſe, ſo muſt the commotion in the Atmoſphere decreaſe proportionally: by which the moſt ſolid and heavy Bodies would ſooneſt fall down. And one would think that it would not be the work of one or two years, but it would require ſome thouſands of years after the ſolid Bodies firſt began to fall, before the Atmoſphere could ſettle it ſelf into a regular and uniform Body. And therefore ſince all theſe diaphanous and ſolid Bodies which compoſed the outward Cruſt fell ſo ſlowly and by degrees on the Abyſs, and ſince at the time they were all there, they were not able to darken the Atmoſphere; I think that by their ſlow and gradual deſcent, they would not fall ſo thick upon one another, but that the Comets Atmoſphere would ſtill be penetrated and illuminated by the light of the Sun.

But if I ſhould grant to Mr. *Whiſton*, that there were ſuch dark and thick Clouds in the Atmoſphere of the Comet as were ſufficient to intercept all the light that ſhould be derived to it from the Sun; yet if we conſider that the central ſolid of a Comet, is a Body which by reaſon of its near approach to the Sun, is ſcorched and burned by very intenſe heat, and that all ſolid and hard bodies when they are heated to any conſiderable degree are clear and luminous; we muſt acknowledge that the proper and native light of Comets, if I may ſo call it, is very conſiderable; and therefore upon this ſingle account of a Comets proper light, it cannot be ſuch a dark and obſcure Body as that Chaos was, from which the world had its Origination.

Since then the Atmoſpheres of Comets are clear and pellucid luminous Bodies, through which we can diſtinctly view their central ſolids; and ſince the Chaos out of which the world was made from its very Original, was a dark and confuſed heap of Bodies without the leaſt glimmerings of light, which was not created till the firſt day of the Hexaëmeron; it is plain that this Chaos could never be the Atmoſphere of a Comet, and therefore Mr. *Whiſton*'s firſt Hypotheſis is but ill grounded.

It is alſo to be obſerved, that the greateſt part of theſe ſolids, which compoſe our upper Stratum, conſiſt of Stones, Sand, and Gravel; and that they when they are once heated to any conſiderable degree, are neceſſarily melted and turned into Glaſs. Now if they had ever exiſted in the Atmoſphere of a Comet, when it was near the Sun, they muſt have ſuſtained a degree of heat ſome hundreds of times greater than the heat of red hot Iron; and conſequently they muſt have been melted: and during the time of their immenſe heat they would have compoſed a fluid, which afterwards when the Comet was cooled, would appear in the form of Glaſs; by which it is plain, that thoſe Bodies never were in the Atmoſphere of a Comet, for otherwiſe they could never have appeared to us in the form they are in at preſent.

Mr. *Whiſton* aſſerts, that there are very many, and very conſiderable Phænomena of nature, which require a central force, or internal heat, diffuſing warm ſteams every way from the centre to the circumference; and eſpecially he ſeems to be pleaſed with Dr. *Woodwards* method of raiſing Vapours through the Earth to furniſh the Rivers with water by the help of a central fire; which he thinks is eaſily accounted for, by ſuppoſing the interior ſolid of the Earth to have been the *Nucleus* of a Comet, that once in its approach to the Sun had acquired an immenſe heat which it doth ſtill in a great meaſure preſerve: but this Opinion, tho' it has been maintained by a great many Learned Men, ſeems to be very improbable. For if I ſhould ſuppoſe that there was ſuch a central fire, yet it is not to be imagined, that it could ever diffuſe it ſelf, and penetrate the exterior parts of the Earth. We know by experience, that if a ſtone wall of four or five foot thickneſs be heated red hot upon one ſide, that the other continues as cold as before, without being ſenſibly affected with the heat which is intenſe on the oppoſite ſide. Since then we ſee that an intenſe heat is not able to penetrate through a ſtone wall, how can we ſuppoſe, that it ſhould diffuſe it ſelf through a denſe and heavy fluid, an hard and diaphanous Cruſt of ſome hundreds of miles thickneſs?

I know none of the Phænomena of nature that do neceſſarily require a central fire. For as to burning Mountains and Volcano's, if Mr. *Whiſton* will be pleaſed to conſult *Borelli de incendiis Montis Ætnæ*, he will eaſily be convinced, that its fire doth not proceed from the Centre, but that its kindled very near the ſurface of the Mountain. And as for Rivers, I believe it is evident, that they are furniſhed by a ſuperior circulation of Vapours drawn from the Sea by the heat of the Sun, which by Calculation are abundantly ſufficient for ſuch a ſupply. For it is certain that nature never provides two diſtinct ways to produce the ſame effect, when one will ſerve. But the increaſe and decreaſe of Rivers, according to wet and dry Seaſons of the year, do ſufficiently ſhew their Origination from a Superior circulation of Rains and Vapours. For if they were furniſhed by Vapours exhaled from the Abyſs through ſubterraneous Pipes and Channels, I ſee no reaſon why this ſubterraneous fire, which always acts equally, ſhould not always equally produce the ſame effect in dry weather that it does in wet. Beſides this, ſince the Mountainous Columns are erected not on the Surface of the water, but ſtand immediately on that denſe and heavy fluid which covers the central ſolid; I cannot eaſily conceive how water ſhould ever come to the bottom of the Fiſſures to be raiſed into Vapours. Nor can I well conceive that prodigious heat, that muſt be ſufficient to raiſe as much Vapour through ſome ſmall Fiſſures in Mountains as the heat of the Sun is able to do from the whole Surface of the Sea.

I know the maintainers of this Opinion uſe to alledge, that there are Springs and Fountains on the tops of Mountains, which cannot eaſily be maintained by a Superior circulation of Vapours: but I beg thoſe Gentlemens pardon, for I can give no credit to any ſuch Obſervations; for I am well aſſured, that there are none of thoſe Springs in ſome places where it is ſaid they are. And particularly that Learned and diligent Obſerver of Nature Mr. *Edward Lloyd* the Keeper of the *Muſæum Aſhmoleanum* aſſured me, that throughout all his Travels over *Wales*, he could obſerve no ſuch thing as a running Spring on the top of a Mountain. On theſe conſiderations, I think it is not in the leaſt probable, that Rivers and Springs proceed from Vapour, that is, raiſed by a ſubterraneous heat through the Fiſſures of the Mountains.

I come now to conſider the way Mr. *Whiſton* makes uſe of, to explain the formation

mation of the Sun, Moon and Stars, by which he ſays in the *Moſaical* account of the Creation, no other thing is underſtood than the rendering of them viſible and conſpicuous to a Spectator on the face of the Earth: for before the fourth day according to him, the Air was much crowded with thick and opake Clouds, which would very much darken the face of the Earth, and keep a Spectator on it from being able to perceive either Sun, Moon or Stars, which were created long before that time. In this place I think Mr. *Whiſton* has not exactly obſerved his firſt *Poſtulatum*, *viz.* that the obvious and literal ſenſe of Scripture is the true and real one, where no evident reaſon can be given to the contrary. For ſince the formation of the Sun and Stars at that time was poſſible, and the Scriptures poſitively tell us, that they were made by God Almighty at that time; I think there can be no evident reaſon given which will be ſufficient to juſtify ſuch a forced and ſtrained ſenſe as he has here put on the words of Scripture.

But tho' I ſhould ſuppoſe that the literal ſenſe of Scripture did not in the leaſt contradict ſuch an expoſition, yet it appears to be impoſſible on his Hypotheſis for theſe reaſons. Firſt, I have already proved that the Atmoſphere of a Comet is a very clear and pellucid Body that doth freely admit both the light and heat of the Sun through it; and conſequently there is no doubt to be made, but that an Eye placed within would have the Sun very viſible and conſpicuous to it. It is evident therefore, granting this Hypotheſis of the Earths being formed from the Atmoſphere of a Comet, that the *Moſaick* account of the formation of the Sun and Stars can never be underſtood of rendering them viſible; ſince according to ſuch an Hypotheſis they muſt have been always ſo.

2dly, Whatever Mr. *Whiſton* may imagin of the Sun, yet it is certain that the Moon at the time of the *Moſaick* Creation was formed or at leaſt placed in its orbit, and made to turn round the Earth; for no Comets have any ſecondary Planets which move round them: ſince then the Moon did not before that time appertain to the Earth but was really at the time of the *Moſaick* Creation, if not Created and formed, at leaſt brought into a new orbit, and made to move about us to give us Light in the night time; we muſt neceſſarily acknowledge, that when God is ſaid to have made the Moon, there muſt be ſomething more underſtood than a mere rendering of it viſible; and becauſe the word *Made*, is equally applyed in Scriptures both to the Sun and Moon; there is no doubt but that it is to be underſtood in the ſame ſenſe of both, that is in a literal one, *viz.* That they were really Created, when in Scripture they are ſaid to be made on the fourth day of the *Moſaick* Creation.

3*dly*, Mr. *Whiſton* ſuppoſes that the Sun acted ſo very ſtrongly the ſecond day of the Creation on the Earth, that it was able to draw a prodigious quantity of Vapours into the Air, ſuch as were ſufficient enough when they fell in Rain, to produce all the Seas, Lakes and Rivers that were in the Primitive Earth: but how the Sun could have ſuch an extraordinary influence on the Earth without being viſible, is a queſtion which I believe cannot be eaſily anſwered; for there is a great difference between the heat of the Sun when it ſhines bright and clear, and its influence when it is obſcured with Clouds and Vapours; Indeed one would think that it would require a prodigious heat, to elevate ſuch a quantity of Vapours in one half year, as would fill all the Channels of the Seas and Lakes with water. I am ſure that the Sun now when it is brighteſt is not able to perform any ſuch effect; for if we ſhould collect all the Rain that falls in the ſpace of a year on the ſurface of the Earth, it would not riſe, on the whole ſurface of the Earth, above a foot and a half high; which is not enough to make the thouſandth part of an Ocean. Since then according to Mr. *Whiſton*, the Sun was capable on the ſecond day, to perform an effect ſome hundreds of times greater than its heat when it ſhines cleareſt and brighteſt is able to do on our Earth, I think we may undoubtedly conclude that it muſt have been viſible even at that time; that is, it muſt have been viſible before it was ſaid to have been made, which cannot be imagined in whatever ſenſe we take the word *made.*

Indeed I cannot but think it ſtrange, that Mr. *Whiſton* ſhould ſuppoſe, that there was ſome hundreds of times more water drawn by the heat of the Sun in one half year, than there is now exhaled from our Earth in double that time; ſince he himſelf acknowledges, that we do every day enjoy more of its Heat and Light than the Primitive Earth could be ſuppoſed to have done for a conſiderable ſpace of time: this I confeſs ſeems to me, to be a very wonderful and unaccountable effect, and not at all proportional to its cauſe; but if he will ſuppoſe that it was really ſo, I need not argue much againſt it, ſince I am ſure, ſuch a ſuppoſition muſt neceſſarily allow the Sun to have been at that time viſible.

Mr. *Whiſton*'s third Hypotheſis is, that the diurnal rotation of the Earth, did not commence till after the fall; ſo that till that time, Days and Years were exactly equal and the ſame; the Earth having no other motion but its annual one round the Sun, all the World would have for one half of the year a continual Day, and for the other a continual Night. Here I muſt freely own my ſelf to be one of thoſe Readers to whom Mr. *Whiſton* ſays this aſſertion will appear one of the greateſt of Paradoxes; for when I conſider the vaſt and prodigious cold that muſt be occaſioned on the Earth, by the total abſence of the Sun for one half year together, I think that it would be ſo exceſſively great, as that 'twould have been impoſſible to be endured by Creatures made of Fleſh and Blood. We are extreamly ſenſible of the great cold we ſuſtain by having our Night in the Winter ſixteen hours long, but yet it is nothing to what it would be, were the Sun for half a year together abſent from us: how cold and uncomfortable a darkneſs muſt that have been in which our firſt Parents paſſed the one half of their Paradiſaical life, when in the other half they muſt have been ſcorched and roaſted with the immenſe heat of the Sun, which ſhined on them continually for as long a time, as they were before in the dark. This heat in my opinion, would have quite withered the Herbs and Plants which were then deſigned to be the food of Mankind; it would have forced our firſt Parents to ſeek for ſhelter in Dens and Caves, which would have been, in ſuch a ſtate, more convenient than the Garden of *Eden*; and it would have been altogether as unſupportable as the former cold. It is evident that ſuch a ſtate would be ſo far from being agreeable with that happy and pleaſant Paradiſaical life which our firſt Parents are ſaid to have lead in their ſtate of Innocency, that the *Legend-makers* and *Poets*, thought it a fitter repreſentation of Hell and its Torments, than of that ſtate of happineſs; ſome of them having feign'd that there were Ghoſts brought from Hell on purpoſe to inform us that a great part of the miſeries of the damn'd conſiſted in their being driven from extreme hot places to extreme cold ones.

There is one very convincing Argument againſt this ſuppoſition ariſing from the conſideration of the nature of Animals, whoſe Blood and other liquors that run in their Bodies are not able to endure two ſuch oppoſites as the extreme heat cauſed by the Sun while it ſhined for one half year without intermiſſion on the ſame place; and the extreme cold that muſt ariſe through his abſence for the ſame time. For if we ſhould ſuppoſe that theſe animal liquors were of ſuch a a conſtitution and internal heat as not to be frozen by an extreme cold, yet it is certain that they muſt evaporate and be exhaled by the extreme heat that came after it in the day time: or if they were able to ſuſtain ſuch an extreme heat without evaporation; then without doubt they could not preſerve themſelves from freezing in an extreme cold which they muſt have ſuffered in ſuch a Winter or half a years night.

I know there are Animals which live near the fire, and are able to endure an extraordinary heat; as there are others that live near the Pole and in very cold Climates: but it is not imaginable there can be any ſuch that can live both in exceſſive heat and exceſſive cold; it being impoſſible that ever they can endure two ſuch oppoſite extremes. Tho' this ſeems to be a very preſſing difficulty againſt ſuch an Hypotheſis, yet there is another that I think as inſolvable, ariſing from the conſideration of the nature of Plants.

We know that there is a certain determinate degree of heat neceſſary for the production and vegetation of moſt Herbs, and for the ripening of their Seed ſo that a leſs degree of heat would never bring the Plant to perfection, and a greater would quite wither it before its Seed could be ripened and fit for the production of a new Plant of the ſame ſpecies. It is eaſily obſervable how great difficulty there is, and how much pains muſt be taken, by hot beds, and other artificial helps to raiſe Plants in this Climate, which are tranſplanted hither from the *Torrid Zone:* but this difficulty proceeds no doubt, from the want of ſuch a due influence of the Sun as was neceſſary for the production of theſe Plants; ſo that by reaſon of the great difference between the heat which they had in their own proper Soil, and that which they participate of here, it is hard to bring them to perfection: but if we ſhould ſuppoſe this alteration to be ſome hundred of times greater than it is, without doubt we ſhould conclude it impoſſible for any ſuch Plants to grow with ſo little a degree of heat. But this muſt have been the true caſe of the Plants in the Primitive Earth: At firſt before the diurnal rotation of the Earth began, they ſuſtained a degree of heat ſome hundreds of times greater, than the greateſt heat we have in Summer; but after the Earth began to turn round its Axis, the heat and action of the Sun on them came to be of the ſame force and tenour that it is of at preſent; but I have obſerved before, that all plants and Herbs require a certain determinate degree of heat and influence from the Sun; and as a much greater heat will wither them, ſo leſs will never bring them to perfection: on which account it ſeems to be naturally impoſſible, that ever any of theſe Plants, whoſe nature and conſtitution was fitted for the heat of the Sun, before the commencement of the Earths diurnal rotation, could ever be brought to perfection after it began to turn round its Axis in the ſpace of twenty four hours, by which the action of the Sun would be very much leſs than before. If therefore the Earth had no diurnal rotation till after the fall; and if then only it began to turn round its own Axis, there muſt have been ſuch great and extraordinary changes and alterations of heat and cold introduced by this new rotation, as would neceſſarily require new Species of Plants and Vegetables of different natures from the former ones, which would better agree with the new rotation and conſtitution of the Earth, and the action of the Sun. That is, God Almighty muſt have created new and different ſets of Plants, or at leaſt have quite altered and changed the natures of the old ones, which we can hardly imagin to be done.

It is on the account of theſe reaſons that I cannot be induced to believe Mr. *Whiſton*'s Hypotheſis, that the Earth had no diurnal rotation before the fall, to be probable; it ſeeming to be far more agreeable to the Laws of Nature and Philoſophy, that the Earth received both its annual and diurnal motions at the ſame time, *viz.* when it was firſt Created.

Theſe are the chief and principal Remarks that I have made on the Original State and Formation of the Earth; I will now briefly conſider his Theory of the Deluge which is in ſhort thus.

He ſuppoſes that a Comet at the time of the Deluge came very near and paſſed by the Earth; that the Comet, when it came below the Moon, would raiſe a vaſt aud ſtrong Tide, both in the Seas that were then on the Surface, and in the Abyſs, which was under the upper Cruſt of the Earth, after the ſame manner as the Moon doth at preſent in the Ocean; that this Tide would begin to riſe and encreaſe all the time of the approach of the Comet; and would be at its greateſt height, when the Comet was at its leaſt diſtance from the earth. By this tide and the attraction of the Comet, he ſuppoſes that the Abyſs would put on an Elliptick or rather an exactly oval figure; whoſe ſurface being much larger than the former ſpherical one, the exterior cruſt of earth, which lay upon it, muſt conform it ſelf to the ſame figure, which it could not do as long as it remain'd ſolid and conjoin'd; and therefore it muſt of neceſſity by the violent force of the tide be ſtretched and broken, and have innumerable fiſſures made quite through it. After this he ſuppoſes that the Comet in its deſcent towards the ſun paſſing cloſe by the body of the earth involved it in its Atmoſphere and tail for a conſiderable time, and left prodigious quantities of condenſed and expanded vapours on its ſurface, a great part of which being very much rarify'd after their primary fall, would be immediatly drawn up into the Air again, and afterwards deſcend in violent and *outragious* Rains upon the Earth; and would be the cauſe of the forty days rain mentioned in Scripture. The other great Rain, which together with the former, laſted an hundred and fifty days, was occaſioned as he thinks, by the Earths being involved a ſecond time in the Comets tail; from which, and from its Atmoſphere he derives one half of the water, which ſerved for the Deluge. The other half he ſuppoſes was deduced from the ſubterraneous Abyſs, the fluid whereof he ſays was forced upon the Surface of the Earth, by the vaſt and prodigious preſſure of the incumbent water that was derived from the Comets Atmoſphere and Tail, which he ſuppoſes, would preſs downwards with a mighty force, and endeavour to ſink the outward Cruſt of the Earth into the Abyſs: by which vaſt quantities of the ſubterraneous fluid, would be forced and raiſed upon the Surface of the Earth, through the Cracks and Fiſſures, that were made in the Cruſt by the violence of the Tide in the Abyſs. By theſe methods Mr. *Whiſton* ſuppoſes that there was water enough brought on the Surface to cover the face of the whole Earth for the perpendicular height of three miles, that is, above the tops of the higheſt Mountains. But he further ſuppoſes, that neither that water which was derived from the Comet, nor that which was forced up from the bowels of the Earth, was pure Elementary water, but rather a thick and muddy fluid, which he ſays being heavier than water, ſunk to the bottom and covered the Earth, for the depth of 166 feet. After having thus formed the Deluge, his next great work is to remove theſe waters which were brought on the Earth; and this he ſuppoſes to be performed by a wind, which dried up ſome, and forced the reſt through the Cracks and Fiſſures of the Earth into the Abyſs, in which a great part of them had been before, and from whence they were derived.

Theſe are the ſuppoſitions by which Mr. *Whiſton* pretends to account for all the Phænomena of the Deluge. But tho' I can eaſily allow the firſt Hypotheſis to be true, *viz.* That a Comet at the time of the Deluge came very near and paſſed by the Earth, ſince its approach at that time is not only made poſſible but alſo very probable by him; yet I cannot admit of the particular explications he has given of ſeveral of the Phænomena of the Deluge; a great many of them, as he has explained them, ſeeming to be no ways agreeable to the Laws of Mechanicks and Philoſophy.

For firſt, tho' it is certain, that a Comet, when it paſſed by the Earth, would raiſe a very ſtrong and prodigious Tide in the Seas that were then on the Surface; yet I cannot perceive that ſuch an effect would be produced in the Abyſs, which he ſuppoſes to be a denſe and heavy fluid encompaſſed on all ſides with a thick and ſolid Cruſt of Earth lying cloſely upon it. For Tides being only a violent ſwelling and motion of the waters produced by the attraction of ſome great Bodies that come near them, if we ſhould ſuppoſe that the waters were every where ſhut up within a ſolid Orb lying on them, ſo that there were no room or ſpace left for them to move in, it is plain that in ſuch a caſe there could be no Tide or agitation of the waters, but they would remain in the ſtate they were in before; nor could they preſs ſtronger on that Orb which encloſed them, than Sand, Gravel, or any other firm and hard Bodies would do, that could fill their place; all Bodies whether firm or Fluid, being equally attracted, when the attracting Body is at the ſame diſtance from them. This being then the true caſe of the Abyſs, which Mr. *Whiſton ſuppoſes* to be encloſed by the thick ſolid and upper Cruſt of the Earth, which preſſing ſo cloſe upon it as to leave no void ſpace, at leaſt not ſuch a one as would make room enough for any conſiderable commotion of the waters; and becauſe fluids are not more attracted than ſolids are; it is plain that by the Tide of the Abyſs, and the attraction of the Comet, there could never be produced any greater effect on the Cruſt, which encompaſſed the ſubterraneous fluid, than if the whole Earth had conſiſted of firm and ſolid matter, without any Abyſs. It is certain therefore, that ſince there was no tide in the Abyſs, there could be no cracks and fiſſures made in the Earth by it.

To explain the great rains, which fell on the Earth during the time of the deluge, Mr. *Whiſton* aſſumes a propoſition which I believe he can hardly prove, *viz.* that after the Earth was involved in the Comet's Atmoſphere and tail, and had acquired a prodigious quantity of condenſed and expanded Vapours that fell on its ſurface, a great part of them being much rarify'd, would be drawn up again into the Air, and afterwards deſcend in violent and outragious rains. Now if we conſider the incredible velocity, with which theſe Vapours deſcended (which Mr. *Whiſton* calculates to be ſo great, that they deſcended eight hundred and ſixty eight miles in a minute) and the great reſiſtance they met with in their deſcent through the Air, and the force by which they fell on the ground; we muſt neceſſarily acknowledge, that they muſt have been condenſed and turned into Water, by ſuch a reſiſtance and fall. For it is certain, that when Vapours fall, they muſt meet with a great check and reſiſtance from the Air, by which their parts will be preſſed cloſe together; and as their velocity encreaſes, ſo would the reſiſtance and their denſity till at laſt their parts come to be as cloſely united as it is poſſible, and then they'd fall in the form of Water. Thus it is without doubt, when it rains; for we muſt not imagine, that rain drops have the ſame form and denſity in the Clouds with which they arrive at the ground, for Water being of a greater intenſive gravity than Air, it is impoſſible, that it ſhould be ſuſtained in it, but when it is expanded into Vapour.. Now it is plain by obſervations on the Bareſcope, that, whenever

ever the Vapours begin to deſcend, the Air is lighter than it was before; it therefore not being able to ſuſtain them, they muſt fall to the ground; but in their way they meet with a great reſiſtance, and check from the Air, and ſo muſt neceſſarily be condenſed and fall in drops of Water on the ground. And ſince the reſiſtance of the *medium* is always as the ſquare of the velocity with which the Body moves through it, and becauſe the velocity of vapour which fell from the Comet to the Earth, muſt have been according to Mr. *Whiſton*, ſome thouſands of times greater than the velocity with which common Vapour or Rain deſcends, it muſt needs follow, that the reſiſtance the Vapour, which was derived from the Comet, met with, was ſome millions of times greater than the reſiſtance of common Vapour when it deſcends; but the reſiſtance of common Vapour, when it deſcends, is great enough to condenſe it into water; it is evident therefore, that all ſuch Vapours as deſcended from the Comet muſt have been of neceſſity condenſed into water long before they ever touched the Earth. Seeing then they deſcended on the Earth in the form of water, and ſeeing there was no ſufficient cauſe that could immediately raiſe and mount them up again, the heat of the Sun not being great enough for ſuch an effect; it is plain, that they could never riſe up again to produce the forty Days Rain mentioned in Scripture.

Mr. *Whiſton* having, as he imagins, explained the great Rains, which fell on the Earth at the time of the Deluge, doth in the next place proceed to ſhew, how the waters of the Abyſs were forced up to the Surface of the Earth, and became a great cauſe of the Univerſal flood. This he ſuppoſes to be performed by the vaſt quantity of waters, that had deſcended from the Comet, which, he ſays, being of a prodigious weight would preſs the Cruſt of the Earth downwards with a mighty force, and endeavour to ſink it deeper into the Abyſs; by this preſſure the waters of the Abyſs would be forced upwards through the Cracks and Fiſſures newly made by the violence of the Tide on the Surface of the Earth. He endeavours to illuſtrate this method of Operation by the Example of a Stone or Marble Cylinder, exactly fitted to a hollow Cylindrical veſſel, that it may juſt aſcend or deſcend freely within it: He ſuppoſes the Stone Cylinder to have holes bored in it quite through, parallel to its Axis, and let down in the hollow Cylinder, which is half full of water, till it touch the water; then if each of the holes be filled with Oil or ſome other fluid lighter than water, he ſays that the weight of the Cylinder preſſing on the water, would ſqueeze the Oil on its Surface through the holes, and throw it out with ſome violence, and this would be a juſt repreſentation of the Deluge.

I muſt beg Mr. *Whiſton*'s leave to think this experiment very far from being any way a juſt repreſentation of the flood; the caſe being very different, when the Solid is ſpecifically heavier than the Fluid in which it is put, from what it is, when the Solid is ſpecifically lighter than it. In the one caſe, the Solid would deſcend and force both Oyl and water up with a conſiderable force, if the holes be ſufficiently ſmall: In the other caſe, when the lighter Solid is put down, and ſwims in the fluid, neither Oyl nor Water can aſcend, becauſe the Body it ſelf cannot deſcend. Now by Mr. *Whiſton*'s own Hypotheſis, the Cruſt of the Earth is lighter than the Fluid in the Abyſs; and therefore it is clear, that it can neither deſcend as the Stone Cylinder would do in water, nor force the Fluid in the Abyſs to aſcend, by its preſſure. This will clearly appear by Mr. *Whiſton*'s repreſentation a little rectified. For if inſtead of the Cylinder of Stone, we ſhould take a Cylinder of Wood, which is lighter than Water, and bore it through with holes as the other was, and put it into the Water, till it ſwims, and afterwards pour Oyl into the holes; it is plain that neither Water nor Oyl could ever be raiſed to the top of the Cylinder: Nay the Water would be ſo far from riſing higher by the additional preſſure of the Oyl, that I can demonſtratively prove, it would fall lower, and the Solid would not

Fig 10

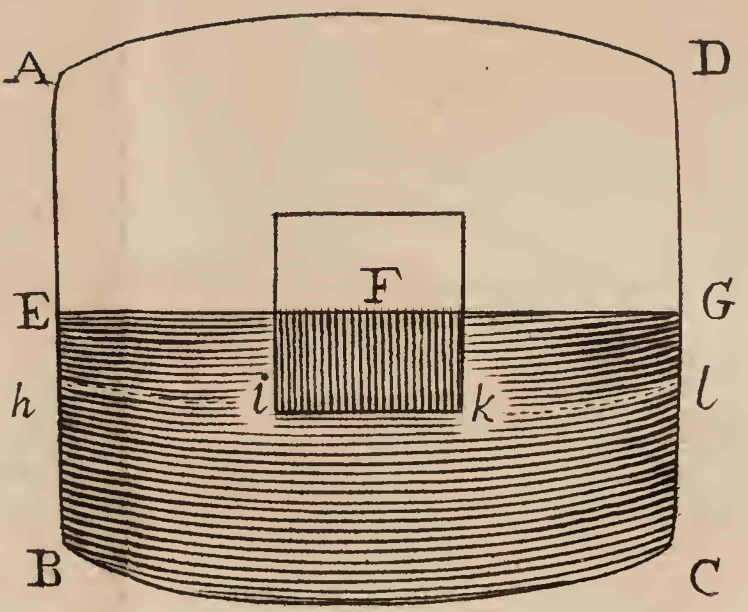

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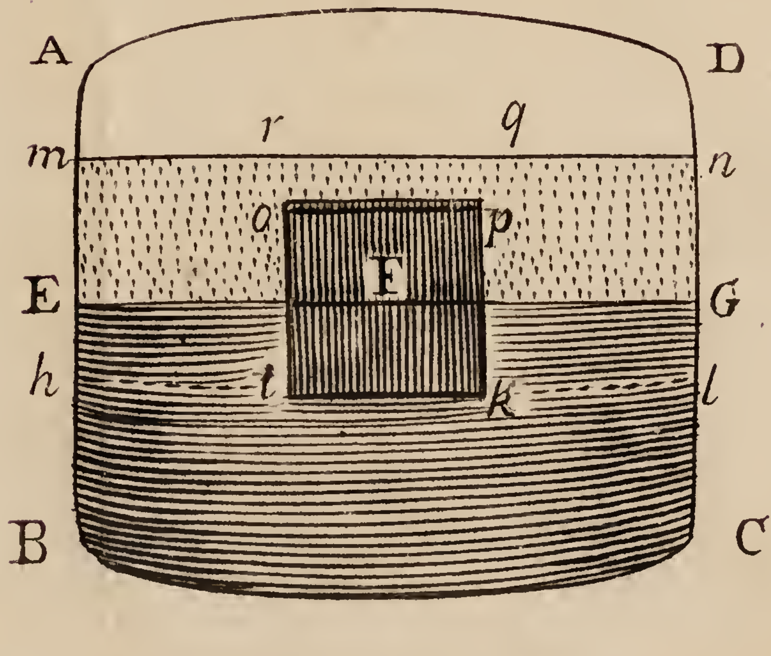
Fig. 11.



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ſink ſo far into the Water, as it did before the Oyl was put in. [*Fig.* 10. *Plate* V.] For let A B C D repreſent a Veſſel half full of Water, in which F is a Solid ſwimming; it is evident, that the Solid will ſo far deſcend in the Water, till the Surface *i k* of the Water be as much preſſed by the weight of the Solid, as the Surfaces *h i*, *k l* are by the weight of the incumbent fluid.

Now if we ſhould pour Oyl into the ſame Veſſel above the Water and above the Solid, as in the Figure, [*Fig.* 11. *Plate* V.] where *m* E G *n* repreſents Oyl; it is plain, that the Surfaces *h i*, *k l* are preſſed with the additional Columns of Oyl *m* E *o r*, *q p* G *n*, which being greater than *r o p q*, the additional Oyl wherewith the Surface *i k* is preſſed, will have a ſtronger preſſure than the Surface *i k* has; and therefore the Water at *h i*, *k l*, being more preſſed than that which is at *i k*, it muſt deſcend, and force that which is at *i k* further up: that is, the Solid will be forced upwards, and will be ſo far from being heavier than 'twas in reſpect of the water, that it will be relatively lighter; and this muſt have been the true caſe of the Water at the Deluge. For when it fell on the Surface of the Earth, it would deſcend into all the Cracks and Fiſſures thereof, till it had quite filled them; for water cannot lye on any Surface except all the Holes and Fiſſures of that Surface be firſt filled. This adventitious water in the Fiſſures preſſing more ſtrongly on the Surface of the Abyſs than the Water, which lay on the Surface of the Cruſt could do, would force the Fluid immediately under it to deſcend, and that which is under the Cruſt to aſcend. Thus I think, it is abſolutely certain, that in this caſe, the water in the Abyſs would be ſo far from being able to aſcend, that it muſt neceſſarily deſcend by the preſſure of the incumbent water; and the whole Cruſt muſt have been raiſed higher, not immerg'd deeper in the Abyſs.

There is but one poſſible caſe, wherein the preſſure of the water could ſink the Cruſt deeper into the Abyſs, and that is, if the waters which lay on the Surface, could not deſcend through the Cracks and Fiſſures of the Earth. And tho' I can ſee nothing that can hinder them from deſcending; yet if I ſhould ſuppoſe, that they did not, I can evidently prove by Calculation, that ſuch a preſſure could never raiſe the Abyſs above the Surface of the Cruſt.

To demonſtrate this, I aſſume the height of the water, which was derived from the Comet, to have been a tenth part of the thickneſs of the whole Cruſt; tho' doubtleſs this is much greater than in reality it can be allowed to have been: and becauſe, according to Mr. *Whiſton*, the Columns of which the Cruſt is compoſed, are about four times heavier than common water, it follows, that a Column of the ſame ſpecifick gravity with the reſt of the Cruſt, Crruſt, whoſe baſe is equal to the baſe of the incumbent Column of water, and one fourth part of its height will weigh as much, or preſs the Cruſt as much downwards as the whole Column of water could do; but the height of the water being a tenth part of the depth of the whole Cruſt, the height of the additional Column that weighs as much as the water, muſt be a fortieth part of the depth of the Cruſt. From hence it follows, that the height or thickneſs of the Cruſt before the additional Column is laid on, is to its thickneſs after the additional Column is laid on, as 40 is to 41. The whole problem then is plainly reduced to this; Having two Cylinders or Columns of the ſame intenſive gravity, but of different heights that ſwim in any Fluid, to find what proportion the parts or heights immerged bear to one another. By a known propoſition in Hydroſtaticks, the part immerged of each Cylinder, bears the ſame proportion to the whole Cylinder, that the intenſive gravity of the Cylinder bears to the intenſive gravity of the Fluid; from thence it is evident, that the parts immerged have the ſame proportion that their reſpective whole Cylinders have to one another; which in the preſent caſe is as forty to forty one. By this it is clear, that the additional weight of the incumbent water would not ſink the Cruſt above one fortieth part deeper into the Abyſs, than it was before; and therefore it could never riſe by ſuch a preſſure ſo high as the Surface of the Earth. But if we ſhould ſuppoſe that the preſſure on the Cruſt ſhould be ſo great as to preſs the Abyſs upwards, and the waters in it to the Surface of the Earth; it is certain, that in ſuch a caſe, when the waters in the Abyſs had aſcended to the Surface, there muſt be a communication between the Abyſs and it: by this communication, the waters on the Surface muſt neceſſarily deſcend and lye immediately on the Abyſs; and ſo the caſe would be reduced to the former one, where the water is ſuppoſed to preſs immediately on the Fluid in the Abyſs; by which preſſure, the Cruſt would be ſo far from ſinking deeper, that it would be raiſed to a greater height, as I have ſhown before. From all this it is demonſtratively evident, that by no ſort of preſſure of the incumbent fluid the Abyſs could be forced upwards to ſpread it ſelf on the Surface of the Earth.

Another Argument, which may be urged againſt deriving water from Mr. *Whiſton*'s Abyſs, is this; He ſuppoſes the Abyſs to conſiſt of a very denſe Fluid, whoſe intenſive gravity is greater than the gravity of the Cruſt which ſubſided into it: but this Cruſt being three or four times heavier than water it muſt be immediately contiguous to the Abyſs; ſo that there can be no room for any conſiderable quantity of water to lye between them; and therefore it is plain that whatever water was raiſed from the Abyſs muſt be only on the Cracks and Fiſſures of the Earth. But Mr. *Whiſton* ſuppoſes that the half of that water at leaſt which was neceſſary for the Deluge was derived from the Abyſs, that is, as I ſhall hereafter prove, there muſt have been eleven times more water derived from the Abyſs than there is in the whole Ocean; which is a prodigious greater quantity than the Cracks and Fiſſures can be ſuppoſed able to contain. Perhaps Mr. *Whiſton* will grant, that the greateſt part of what was drawn from the Abyſs was not pure water, but that denſe and heavy Fluid on which the Cruſt ſubſided: but if it were ſo, it is certain that ſuch a Fluid being heavier than water muſt have taken its place next to the Surface of the Earth, and have filled up all the pits, holes, and valleys that were on the Earth; nay it would have driven the Sea out of its Channel, and would have compleatly filled its place, where it would have remained to this day. It is moſt evident, that if ſuch a thing had happened, there would have been vaſt quantities of that denſe and heavy Fluid ſtill abiding on the Surface of the Earth, and in pits and holes, there being nothing to drive it from thence into the Fiſſures again: But yet it is evident from Obſervations, that there is not any ſuch thing in Nature to be ſeen, and that there is no where to be found any quantity of ſuch a denſe and heavy Fluid, which Mr. *Whiſton* ſuppoſes covered the Earth at the time of the Deluge. There is only a little Quick-ſilver which is found in ſome Mines in the very bowels of the Earth; but the quantity of it is ſo ſmall and inconſiderable, that we cannot poſſibly ſuppoſe it to be the remains of the Fluid in the Abyſs. For if ever there had been any ſuch Fluid on the Surface of the Earth, there muſt have certainly remained greater quantities of it to this day, ſince as I have obſerved before, the very Seas muſt have been full of it.

I freely acknowledge Mr. *Whiſton*'s Hypotheſis about Shells, Bones, Teeth, and other *Exuviæ* of Land and Sea Animals, found and dug out of the Bowels of the Earth to be very Ingenious and more Philoſophical than any other Hypotheſis that I have yet ſeen; ſo that to me it ſeems indeed probable, that the water which made the Deluge from whence ſoever it was derived, had in it much Mud and Earthy matter; which after the waters were gone off, ſettled on the Surface of the old Earth, and became a new Cruſt; in which theſe Shells, Teeth, and Bones ſubſided. This Hypotheſis I think, doth very naturally explain all the Phænomena Dr. *Woodward* mentions in his Theory, and on that account it may be eaſily admitted as a true one.

I come now to conſider Mr. *Whiſton*'s way, by which he ſuppoſes all the waters, that were neceſſary for the Deluge, were drawn of the Earth. He imagins this to be performed partly by a wind which dried up ſome, and partly by the deſcent of the waters through the Cracks and Fiſſures of the Earth; to which the wind by hurrying the waters up and down would be very ſufficient. Before I examin theſe cauſes, it is fit that I ſhould make an eſtimate of the quantity of water, that would be neceſſary to cover the whole Earth above the tops of the higheſt Mountains. Dr. *Burnet* in his *Theory of the Earth*, reckons it to be about eight Oceans of water, ſuppoſing the Surface of the Sea to be equal to the Land, and to be every where a quarter of a Mile deep, taking one place with another. But on the ſame ſuppoſition, I believe, I can more exactly determin it to be near three times as much. I muſt here aſſume, that the height of the higheſt Mountain above the level of the Ocean, is above three Miles perpendicular height. I know *Varenius* in his *Geographia Generalis*, Calculates the height of the *Pico* in the Iſland of *Tenerife*, to be one *German* Mile, or above four *Engliſh* Miles in height: and tho' I am inclined to believe, that its height is yet greater than *Varenius* makes it (for he ſeems to allow too much, both for refraction and errors in the Obſervations;) yet becauſe three Miles is the height, Mr. *Whiſton* ſeems to allow the waters at the Deluge, I will ſuppoſe the Hills no higher; and from thence I will Calculate what water would be neceſſary to make an Univerſal Deluge.

It is evident, upon ſuch a ſuppoſition, that the waters muſt be raiſed beyond three Miles perpendicular height that they may be as high as the tops of the Hills. Now it is eaſy to Calculate how much water would be neceſſary to raiſe the Surface of the Sea to ſuch an height. The Ocean being by Hypotheſis a quarter of a mile deep, there are twelve ſuch quarters in three Miles, and conſequently there muſt not be leſs than twelve Oceans of water lying on the Surface of the Sea, that it may be of the ſame height with the water which covered the Land.

Let me in the next place ſuppoſe the whole ſurface of the Land thickly beſet with Mountains, every one of which was three Miles perpendicularly high: now becauſe three Miles has but a very ſmall proportion to the ſemidiameter of the Earth, it is evident, that the Orb, or rather part of an Orb, conſiſting of waters and Mountains, would be alſo equal to a Cylinder, whoſe height is three Miles, and its baſe a Circle equal to the Surface of the Land. But becauſe the Hills are ſuppoſed to be of a conical Figure, and cones by the 10*th* of the 12*th* of *Euclid*, are the third part of a Cylinder on the ſame baſe and of the ſame height, it is evident that the Hills would make but one third part of the former Cylinder; that is, all the Mountains if they were levelled, would raiſe the Surface of the Earth a mile higher than it is: from thence it follows, that the water, which lay on the Surface of the Land at the time of the Deluge, was equal to a Cylinder, whoſe baſe was equal to the Surface of the Land, and its height two miles. And becauſe in two miles there are eight quarters of one mile, it is plain, that the water, which was neceſſary to cover the Land, muſt be equal to eight Oceans of water; which together with the other twelve, makes twenty Oceans of water. But becauſe the whole Land is not ſo thickly covered with Hills as I have ſuppoſed, (it being indeed not poſſible that it ſhould be) and becauſe there are but few Hills ſo high as I have ſuppoſed them all to be, we muſt at leaſt allow two Oceans more on theſe two accounts: ſo that the whole amounts to two and twenty Oceans of water, which together with the water that doth now compoſe the preſent Ocean, makes three and twenty Oceans of water, which is the leaſt that can be neceſſary for an Univerſal Deluge. If the height of the greateſt hills were four miles above the Surface of the Ocean, as moſt probably it is by *Varenius*'s Calculation, the water, that muſt be required to drown the whole Earth, muſt be no leſs than twenty eight Oceans of water. But I will here ſuppoſe there was no more water, than what was required by the former ſuppoſition.

Tho' it be eaſy for Mr. *Whiſton* to ſuppoſe all this, or even a much greater quantity of water to be derived from the Atmoſphere of a Comet; yet I believe he will not find it ſo eaſy a task to remove it again from the Earth. He himſelf acknowledges, that the Air could receive and ſuſtain but very inconſiderable quantities of it in compariſon of the entire Maſs of waters, which then lay on the Earth. It is not poſſible, that this water could deſcend through the Cracks and Fiſſures of the Earth, which of neceſſity muſt have been all full at the time of the Deluge: for water cannot lye on the Surface of the Earth, till all the Cracks, Holes and Fiſſures in it be firſt filled. This is ſo evidently certain both to ſenſe and experience, that I think it beyond all contradiction true; it being as impoſſible to make water lye on the Surface of the Earth, before all its Cracks, Pits, and Holes are filled, as it is to make a Veſſel retain water, whoſe bottom is bored through with holes.

But tho' I ſhould ſuppoſe that the Cracks and Fiſſures remained empty during the Deluge (which is indeed an impoſſible ſuppoſition;) yet it is certain, that theſe Fiſſures could receive but little more water than what was at firſt derived from them. For the

Cruſt of the Earth according to Mr. *Whiſton*, lying immediately on the denſe and heavy Abyſs, and water being lighter than it, it is abſolutely impoſſible, that ever water ſhould ſettle it ſelf between the Cruſt and the Abyſs. It is therefore clear, that no more water could deſcend through the Cracks and Fiſſures of the Earth than what they were able to contain, or what had firſt aſcended through them to the ſurface of the Earth; which Mr. *Whiſton* ſuppoſes to be half the water neceſſary for making the Deluge, and muſt be according to the former Calculation, at leaſt eleven Oceans of water: Tho' indeed I cannot eaſily underſtand, how 'tis poſſible for them to contain and receive ſo much. What then can we imagin would become of the reſt? for after that the Channel of the Sea was compleatly filled, there would remain eleven Oceans more to be diſpoſed of; which there is no imaginable place in the Earth able to receive. And therefore it is clear even to a demonſtration, that all this water could never be removed by natural means.

Theſe are the chief and moſt ſubſtantial points I have conſidered in Mr. *Whiſton's New Theory*; I might have made ſeveral objections againſt other parts of it, and particularly I might have taken notice of ſome miſtakes he has made in Geometry; but becauſe the Truth of his Theory doth not depend upon them, I have paſſed them over. If Mr. *Whiſton* will be pleaſed to make any anſwer to the Objections, I have here made; I would deſire of him, that, whatſoever difficulties he deſigns to remove, he will do it by clear and diſtinct reaſoning from Mechanical Principles. If he finds himſelf preſſed with any objection, which he cannot anſwer, I doubt not, but that he will have the Ingenuity to own it. I know there are ſome Philoſophers, that never miſs to tell their Readers, they reaſon clearly and diſtinctly, when no body elſe can diſcover the conſequence but themſelves. And when they are ſo preſſed with any difficulty, they make a long diſcourſe about ſome thing the Reader knows not what, and endeavour to get off in a miſt of words; but I expect no ſuch dealing from one of Mr. *Whiſton*'s Candour and Sinceriy.

AN

AN EXAMINATION OF THE REFLECTIONS ON *The Theory of the Earth.*

THE Defence of the Theory which has been lately Publiſh'd in Anſwer to my Examination of it is ſtyl'd *Reflections on the Theory of the Earth*; But if its Author had obſerv'd the Title, and made more Reflections on the Theory, tho' fewer on the Examiner, he had acted more like a true Philoſopher, and perhaps might have ſaved himſelf the labour of Publiſhing any thing more than an ingenious acknowledgment of its errors, and me the trouble of a Reply. But ſince the Reflecter has been pleaſed to follow another courſe, I muſt take his work, and conſider it in the method it lyes.

He firſt ſets down three propoſitions which He calls the foundation of the whole work, “ *viz.* That the Primitive or Antediluvian “ Earth was of a different form from the “ preſent. 2*dly*. That the face of the Earth “ as it roſe from a *Chaos*, was ſmooth, “ regular, and uniform, without Mountains “ and Rocks, and without an open Sea. 3*dly*. “ That the diſruption of the Abyſs or the “ diſſolution of the Primeval Earth was the “ cauſe of the Univerſal Deluge. To theſe “ he adds a Corollary drawn from the pri- “ mary propoſitions concerning the poſition “ of the Earth; in which he ſays, that the “ poſture of the Antediluvian Earth or its “ Axis, was not oblique To THE AXIS OF “ THE SUN or of the Ecliptick as it is “ now; BUT LAY PARALLEL TO THE AXIS “ OF THE SUN, and perpendicular to the “ plane of the Ecliptick.” Theſe he makes the only fundamental propoſitions of the Theory, (tho’ the Theoriſt in his ninth Chapter Book II. makes one more concerning the oval figure of the Earth) and tells us, “ That he who will attack it to the purpoſe, “ muſt throw down in the firſt place theſe “ leading propoſitions, and that if the Exa- “ miner had taken this method, and confuted “ the proofs that are brought in confirmation

" of each of them, he needed have done no
" more; but if inſtead of this, a looſe ſtone
" be only picked out here and there, or a
" Pinnacle ſtruck off, it will not weaken the
" foundation.

I cannot imagine how this Author can aſſert that I have not followed this method in refuting the Theory; for if theſe he has mentioned be the the ſubſtantial and vital parts, I have examined every one of them, as will plainly appear to any one, who will read the Examination; ſo that what he has ſaid of me in another caſe, may be very well apply'd to himſelf, *That either he never read over, or does not remember, or which is ſtill worſe, does willfully miſrepreſent what I have written on this ſubject.*

The deſign of the firſt Chapter of the Examination is not as this *Defender* imagines: to prove that the Deluge might have been made by a miracle, but to anſwer the general Argument which the *Theoriſt* with a boldneſs little becoming a Divine, brought for the truth of his Theory, *viz.* * that it could be made no other way, and therefore his method being the only way *poſſible*, was the real one. To this I anſwered, that I thought it poſſible the Deluge might come by a miracle, and that God Almighty was the immediate cauſe thereof, the Scriptures having given us ſuch an account of it in theſe emphatical

* *Engliſh Theory Ch.* 7. *Book* I.

terms, (Gen. 6. 17.) *Behold ſaith God, I even I, do bring a flood of waters upon the Earth.*

But the *Defender* is diſpleaſed becauſe I did not tell him wherein this miracle conſiſted. The truth is, I never thought it my buſineſs to explain miracles; and I wiſh no *Theoriſts* or Philoſophers had ſet up for it. I ſhould be well contented to find in their writings a Mechanical and eaſy account of the common and ordinary Phænomena of nature. But it ſeems this Author will not be ſatisfy'd unleſs I tell him how the increaſe of waters at the time of the Deluge was made on the Earth. I anſwer, that according to the Scripture, ſome of the water was raiſed from the great deep, and ſuſtain'd on the ſurface of the Earth by the hand of Omnipotence, a great part of it deſcended by forty days continual rain; the waters which occaſion'd this rain being either newly created, or riſen from other matter turned into that Element, or brought from ſome other place beſt known to the Divine Omniſcience: which of all theſe three methods was uſed, I will not take upon me to determine; but I think it might have been done by any of them, notwithſtanding the reaſons alledg'd in the ſecond and third Chapters of the Theory, which this Author thinks me oblig'd to anſwer. It ſeems he thinks them very ſtrong and convincing, tho' when I wrote the Examination, I thought them ſo weak and precarious that it would not be worth while to take notice of them. * The arguments againſt a Creation of waters are founded on a notoriouſly falſe notion of the *Carteſian* Philoſophy, *viz.* That matter and ſpace are the ſame: according to which principle 'tis not eaſy to underſtand, how either Creation or Annihilation can be poſſible. Nor do I think the arguments againſt Tranſmutation of Air or other bodies into water, of greater force than the former: For if all bodies be only different in their modifications, motions and figures, I can ſee no reaſon why any body may not be changed, and put on the form of another; and therefore, if according to the Theoriſts principle there is no vacuity in Nature, not only the Air may be changed into Water, but alſo all the ſubtil matter which fills its Pores; and according to this principle of a Plenum, that ſubtil matter will make as much Water as if the ſame bulk of abſolutely ſolid matter were transformed.

The *Defender* alledges, that if I proceed upon ſuch Waters as were already in being, and make them either Supercœleſtial or Subterraneous, I muſt tell him WHAT THESE WATERS ARE, and muſt anſwer ſuch objections as are brought againſt either ſort in the ſecond and third Chapters of the Theory; if he means that I ſhould tell him the nature of this Water, and of what ſort it was, I

* *Engliſh Theory Ch.* 3. *Book* I.

anſwer, that it might be common Water, for that will be ſufficient to drown the World; but if He deſigns that I ſhould tell him from what place it was brought, and how it came there, I muſt own I know not: For to anſwer the queſtion which he makes in another place, I have not yet been all over the Univerſe to make Obſervations, nor have I had any Revelation made me; it is enough both for him and me to ſuppoſe this Water like common Water, and that 'twas brought upon the Earth by the Power of God. The arguments which the *Theoriſt* brings againſt the poſſibility of any ſuch Waters, are ſufficiently anſwered in the 30*th.* and 31*ſt.* Pages of the Examination.

After this, the *Defender* paſſes to the ſecond Chapter of the Examination, where I find he has but little to ſay to the arguments, tho' he would fain have them appear ſmall and trivial. I affirm in that Chapter that moſt of thoſe bodies which compos'd the outward Cruſt of the Earth were heavier than Water, and by conſequence muſt deſcend both through the Oyl and Water alſo; and that tho' ſmall grains of duſt, ſpecifically heavier than Oyl, if thrown upon it would not deſcend becauſe of its tenacity, yet if the weight of theſe particles chanced to be increaſed by the additions of more, they muſt fall down. To this He makes anſwer, that the parts which formed the Cruſt were not *huge lumps of ſolid matter*, but little tenuious particles or ſmall duſt. Did not I make the ſame ſuppoſition, and yet ſhow'd that tho' theſe ſmall particles of duſt when they firſt fell, might have been ſuſtain'd by the Oyl, yet when their bulk came to be increaſed by the falling of a great many others, their weight would be augmented proportionally; upon which account they muſt deſcend like other huge lumps of ſolid matter, and that long before ever they could form a ſolid Cruſt, that would be neceſſary to ſupport the weight of all the reſt of the deſcending particles? But the *Defender* has wiſely paſſed over this part of the argument, knowing it would be a hard matter to anſwer it.

I wiſh the Theoriſt or his Defender would be ſo kind as to give us a ſpecimen of this Operation for the making of an Earth, and becauſe it wou'd be too hard a task to make a whole One, I would deſire them to make a ſmall portion of One; let them take a Veſſel, in which let ſome Water be pour'd in, and after that ſome Oyl, and I would have them try if by throwing on the Oyl, ſmall grains of Sand, Gravel, Clay, Stone, and other Materials heavier than Water, they can form a Cruſt: and we ſhall begin to think the reſt of their Theory poſſible, if this Experiment ſucceeds.

I had another Objection againſt ſuch a formation of the Cruſt, upon the conſideration of the great height, from which theſe particles would fall, by which their force and celerity muſt be very much increaſed, and therefore of neceſſity they muſt pierce the oily liquid, and break thro' to the bottom; this the *Defender* allows of, providing theſe particles deſcended like ſtones or any other ponderous bodies; but He affirms theſe particles deſcended not in that manner, but rather like flakes of Snow hovering and playing in the Air, their courſe being often interrupted and diverted, and their force broken before they arriv'd at the end of their journey. To this I anſwer, that tho' theſe particles were ſmall, yet they were ponderous, being of the ſame intrinſick gravity with the matter of which the outward Cruſt of the Earth is made up, and upon that account we cannot ſuppoſe them to be like flakes of Snow, whoſe weight is but ſmall, and their ſurfaces very large in proportion to their bulk, which therefore muſt ſuffer a far greater reſiſtance than we can ſuppoſe theſe deſcending particles to have done. Beſides, if we conſider the great height from whence theſe particles fell, which the *Theoriſt* affirms to be as high as the Moon; and the thinneſs of the Air at ſuch a height (which muſt be extreamly pure when Mr. *Newton* calculates that now at a Semidiameters diſtance from the Earth; the Air is ſo rare, that one inch of our common Air near the ſurface, if ſo much expanded as that is, would fill a ſphere as large as that of *Saturn*) we muſt of neceſſity think, that the deſcending particles would not meet with ſo great a reſiſtance as the Defender imagines. For whatever interruption or diverſion they met with from the Air in their deſcent, would be inconſiderable. But the greateſt part of it would ariſe from their falling on other particles which were alſo deſcending, tho' not ſo faſt, by which, tho' the velocity of the ſwifteſt body would be diminiſhed, yet according to the Laws of motion, the momentum or quantity of motion of both bodies taken together would remain the ſame, and by conſequence their force upon the oily Orb would be alſo the ſame. I know no way the *Theoriſt* can take to anſwer theſe objections, but by ſuppoſing that the Creation was neither in Spring, Summer nor Autumn, as is commonly ſuppos'd; but that it was in the Winter when both the watry and oily Orbs were frozen, and had conſiſtence enough to ſuſtain theſe particles till they were formed into a ſolid Arch, able to ſuſtain it ſelf; and if he will embrace ſuch an opinion, I ſhall not take the trouble of refuting it, having ſo many others of the ſame weight upon my hands. The Reader may obſerve, that He takes not the leaſt notice of the argument I brought againſt him from Scripture, to prove that there were Metals in the primitive Earth, which he plainly denies.

After theſe things this Author comes to quarrel with me for making inſinuations and ſuggeſtions, as if the *Theoriſt* did not own the hand of a particular and extraordinary providence in the formation of the Earth. I own I did make ſuch inſinuations, and I leave the Reader to judge whether I had not Reaſon to make them. He has openly rejected the Hiſtory of the formation of the Earth as deliver'd by *Moſes*, and has deduced it purely from natural cauſes, and the neceſſary Laws of Mechaniſm. Now if the matter of the Earth from a *Chaotick* ſtate did of neceſſity form and ſettle it ſelf into a habitable Earth, from the ſole neceſſary principles of Mechaniſm and Gravitation, as the Theoriſt has deduced it; I would fain know how this opinion differs from the *Epicurean*, which the *Theoriſt* ſo deſervedly derides? I know the *Theoriſt* talks very much of Providence both ordinary and extraordinary, and makes moſt excellent Diſcourſes againſt the *Epicureans* for denying of it, which I was ſo far from not reading or forgetting, or even willfully miſrepreſenting, that I tranſcrib'd ſome of them in the Examination, as an argument againſt his own Theory.

It is a common thing with Theoriſts and Philoſophers, who are great Politicians in their way, to diſown any opinion which they think will bring upon them the diſpleaſure of any conſiderable part of Mankind, tho' it follows plainly from their Principles; or if that cannot be done, they hide and colour it the beſt way they can, that it may not appear too open and plain. Thus the *Theoriſt* proteſts, that he meant no harm, when he affirm'd the Hiſtory of the Creation as it was deliver'd by *Moſes*, to be fabulous, and ridicul'd the Scriptural relation of the Fall; and I have really the charity to believe him; yet hereby he has ſet the *Atheiſts* and *Theiſts* in a method of attacking our Religion, and given them Schemes by which they think they can defend their own Principles.

After this the *Defender* paſſes to conſider what is ſaid in the third Chapter of the Examination about Mountains; He owns it to be a ſubject that deſerves conſideration, and He ſays, that if the Examiner can prove that there were Mountains in the primitive Earth, He will undertake that the *Theoriſt* ſhall make no further defence of his Theory. The *Theoriſts* great argument why the face of the primitive Earth was ſmooth and without Mountains, depended on the ſuppoſition that the *Chaos* from whence it took its original, was perfectly a fluid Maſs. This I affirm'd to be a precarious Hypotheſis without any foundation in nature, ſince the greateſt part of the bodies we have in the Earth, are hard and ſolid, and there not being a quantity of Water in Nature, ſufficient enough to moiſten and liquify them, the *Chaos* could not be ſo fluid as 'twas neceſſary it ſhould be, to form it ſelf into an uniform ſmooth body. Beſides that, the greateſt part of them, ſuch as Stones and Metals, are uncapable of being liquify'd by water. The Defender's reply to this is, *Very good, what is this to the Theory? Does the Theoriſt any were affirm that there were Stones or Metals in the Chaos, or that they were liquify'd by Water? The Theoriſt owns no ſuch doctrine or ſuppoſition.* I hope the Defender will not think this any anſwer to the objection; I am ſure none of his Readers can. I thought that it concern'd the Theoriſt very much, to prove his *Chaos* to be a fluid Maſs of matter; for otherwiſe it is not neceſſary that it ſhould have its ſurface ſmooth, regular and uniform; at leaſt it is fitting that the objections againſt its fluidity ſhould be anſwer'd. For if the Examiner can prove that the *Chaos* was not altogether ſo fluid as the Theoriſt imagines, and from thence ſhew, that there was no neceſſity that the face of the Earth ſhould be ſmooth and without Mountains, then the *Theoriſts* argument muſt be of little force, and that objection will ſtill very much weaken the truth of the Theory.

I freely own indeed that the World was produced from a *Chaos*, ſuch a one namely as is recorded to us in Scripture; but I am far from granting that the Theoriſt's notion is any ways agreeable to it, he ſuppoſes that all the Elements Air, Water and Earth, with all the principles of Terreſtial Bodies were reduc'd into one fluid Maſs, and mingled with one another, ſo that the parts of any one ſort could not be diſcern'd as diſtinct from the reſt. This I ſuppoſe is a new ſort of *Chaos* which never exiſted any where but in fancy.

It were eaſy for me here to aſſume the Defenders method, and argue againſt it, by putting him queſtions, how, when and where, was this mixing and blending together of all the Materials of Heaven and Earth? By whom, upon what deſign, and for what purpoſe was this done? Was it to the end that they might all ſettle themſelves again in order, and each take its place, according to its ſpecifick gravity; but if the great parts of the World were for the moſt part ſo before, what neceſſity was there for diſturbing them, only that they might range themſelves orderly again. He would do well alſo to tell us, from whence he had this account of the *Chaos*, from Sacred or Profane Writers, if from the latter, we are to value their authority no further than they are agreeable to the Scriptures, ſince it would be no hard task to prove, that it was from the Sacred Hiſtory that the Heathen Writers firſt drew their knowledge of the *Chaos*, which they afterwards corrupted with their own fancies. In the Holy Scriptures I can find no account of the mixing and reducing of all the Materials of the World into one fluid Maſs. *Moſes* indeed tells us, that the Earth was *Tohu* and *Bohu*, which we render without Form and Void, and can we from thence conclude, that all the parts of it were fluid and mixed together? We may allow, that the *Jews* underſtood the ſenſe of theſe words better than we, or any Heathen Writers, and they give them a contrary meaning; for according to the *Syriack* Tranſlation, thoſe words ſignifie, that the Earth was without either Habitation or Cultivation, *Terra erat deſerta & inculta*; in the *Chaldaick* Paraphraſe they ſignifie, *Deſerta & vacua.* The *Targum* of *Jonathan B. Uziel*, ſuppoſes their meaning to be this, *Terra autem erat ſtupor & inanitas, vaſta à filiis hominum & vacua ab omni jumento*; with which the *Jeruſalem Targum* does well agree, according to which Paraphraſe they ſignifie, that the Earth was *Stupor & inanitas & deſolatio à filiis hominum, & omni beſtia vacua*, as that Paraphraſe is render'd in Latin. We may conclude from thence therefore, that the *Jews* thought that all that was mean't by the words *Tohu* and *Bohu* was, that the Earth was Void and Uncultivated, without Ornaments and Inhabitants, Men or Beaſts, or any ſort of Animals.

Nor was the Opinion of the ancient Chriſtian Fathers any wiſe different from that of the *Jews* as to this matter, *Tertullian* in his book againſt *Hermogenes* ſays, *Unde compertus es Hermogenes uniformem & inconditam illam fuiſſe* *materiam quæ ut inviſibilis latebat*; and in the 30*th*. Chapter he plainly proves from Scripture, that there was not a confuſ'd heap of matter mixed and blended together, out of which all things were made. St. *Ambroſe* in the 8*th*. Chapter of his *Hexameron* ſays, that the Earth was *incompoſita utpote ſolertis agricolæ inarata culturis*, *quia adhuc deerat cultor*, and again, *Terra erat incompoſita quia nuda gignentium, nec thoris herboſa riparum, nec opaca nemoribus, nec læta ſegetibus, nec umbroſa ſuperciliis montium, nec odora floribus, nec grata vinetis.* * St. *Baſil* tells us, that the true beauty and compoſition of the Earth ariſes from its great fertility, whereby it is productive of all ſorts of Vegetables, ſuch as Plants of all kinds, lofty and tall Trees, as well thoſe that bear Fruit as thoſe that afford us none, fragrant and ſweet Flowers differing both in colour and ſmell; and the Earth ſays he, being naked and unfurniſhed with any of thoſe ſorts of Ornaments, might well be ſaid by the Scriptures, to be Void and without Form.

In thoſe diſcourſes of the ancient *Jews* and primitive Fathers, there is not one word of a perfectly fluid Maſs of matter out of which

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* *Ἔστι μὲν οὖν τελεία κατασκευὴ γῆς ἡ ἀπ' αὐτῆς εὐθηνία. φυτῶν παντοδαπῶν βλαστήσεις, δένδρων ὑψηλοτάτων προβολαὶ, καρπίμων τὲ καὶ ἀκάρπων, ἀνθῶν εὐχροιαὶ καὶ εὐωδίαι,* &c. *ὧν ἐπειδὴ οὐδὲν οὔπω ἦν, ἀκατασκεύαστον αὐτὴν ὁ λόγος εἰκότως ὠνόμασε.* In his 2*d*. Homily in *Hexam.* near the beginning.

all things were made, there is nothing there of the mixing and blending together of the Elements, and all the Materials of Heaven and Earth; in their Writings we cannot ſee that ſuch a *Chaos* as the *Theoriſt* fancies, was ever either deliver'd or ſuppos'd: we find that their notion about the origination of the World was very different from the Theoriſts, whoſe Hypotheſis is not therefore founded on any authority which is ſufficient to induce us to believe it.

Nor has his opinion any more foundation in reaſon than authority, for if we ſhould allow of the *Theoriſts* account of the Waters that are in the Earth and from thence by computation compare the ſolid bodies with thoſe that are fluid, we ſhall find, that the liquids are not the hundred thouſandth part of the ſolid bodies in the Earth; nay, if we ſhould take in the Atmoſphere, the whole Syſtem of fluids will not amount to the thouſandth part of the ſolid bodies: from which it plainly appears, that the *Chaos* cannot be thought to have been in any manner an entirely fluid Maſs, but rather a hard and ſolid one. For if we take hard bodies as Earth or Clay, and fluid as Water or Oyl, and mix them together in the proportion of eight thouſand to one, or even in that of a thouſand to one; that is, take one inch of fluid matter for a thouſand inches of ſolid matter, the fluids will have but a very ſmall effect on the ſolids. Since therefore the whole compoſition of the *Chaos*, when all its parts were mixed and blended together, muſt not have been fluid, but rather hard and ſolid; I hope the *Defender* will allow the objection to be to the purpoſe, and of force againſt the Theory, which is founded on a contrary ſuppoſition.

Having thus prov'd that the far greateſt part of thoſe bodies which compos'd the *Chaos*, were firm and ſolid, I think it eaſie to ſhew, why there is no neceſſity that an Earth form'd from ſuch a compoſition, ſhould be ſmooth and regular; for it is not ſo with ſolids as with fluids, where all range themſelves according to their intenſive gravities, and ſettle themſelves into a regular and even ſurface; whereas ſolids take their place according to the order they happen to be in, that body coming ſooneſt to its reſt, which is neareſt the Centre, without any reſpect had to gravity or levity, and where theſe bodies happen'd to be thickeſt or higheſt, or their parts leſs coherent, there alſo after their fall would their ſurfaces be higheſt, and the face of the whole would be very rugged and mountainous; the liquids, if we ſhould allow them to ſeparate from the ſolids, would deſcend and fill the Holes, Cavities, and Caverns that were made by the falling of theſe irregular peices on one another, and what was more than ſufficient for this, might ſpread its ſelf upon the Valleys, and leave great protuberances of the ſolid Maſs, as great as any of our Mountains ſtanding out above the ſurface of the Water.

But granting, that the greateſt part of the *Chaos* was a fluid Maſs, I brought another argument in the Examination to ſhew, how the face of the Earth might be mountainous and uneven, by ſuppoſing in the *Chaos* a great many bodies, which, by being in a great meaſure hollow, or faſtned to ſome other matter of leſs gravity than that of the fluid *Chaos*, would ſwim on the ſurface of it, after the ſubſiding of all the reſt, and ſome parts of them ſtanding above the ſurface of the watery Orb, would form Mountains. The *Defender* anſwers this, as he does moſt other objections, by a queſtion, *Who told me that theſe lumps of matter were hollow? Is not this precarious, or rather Chimerical and ridiculous?* I anſwer, I came to know this after the ſame manner, that the Theoriſt knew there were neither Mountains nor Seas in the Primitive Earth; if it be a precarious Hypotheſis I cannot help it, but it is my comfort, that if every thing that's precarious be alſo Chimerical and ridiculous, I know whole Theories that will be ſo likewiſe.

After this he falls into a ſtrain of very learned queſtions, What made thoſe ſolid lumps hollow, when, or where, or how were their inward parts ſcoped out of them? I know none but *Theoriſts* that can give a poſitive anſwer to ſuch nice queſtions; I am content to ſay, they might have been ſo order'd by God Almighty at firſt, for that very end that they might ſwim on the Abyſs: tho' another *Theoriſt* ſays, that the fluid Abyſs was much denſer and heavier than the Mountains, and therefore they could not ſink; and it is indifferent to me which of theſe anſwers he takes, or if he find out ſome other of his own, which he can eaſily do if he has a mind to it, that he will like better. It is enough for me to ſhew, that there is no neceſſity that an Earth ariſing from a *Chaos*, ſhould have its ſurface ſmooth and uniform, as the *Theoriſt* pretends it muſt.

But this *Defender* thinks that it is my opinion, that Mountains were really form'd after this manner, and from thence he proceeds to collect, from my Principles and Conceſſions, that there could be no Sea in the Primitive Earth, and that an Orb of Earth muſt have been built over the Abyſs, and after all he concludes, that I have no good hand in making Mountains.

This way of writing would almoſt tempt me to believe, that he had never read over that Chapter which he pretends to anſwer; for by the reading of it, one may plainly ſee that it was not my deſign to ſettle this, or any other new Theory of my own, about the formation of Mountains; nay, I poſitively declar'd, that I thought *there were other prin-*

ciples concurring to the formation of Mountains, beſides gravitation and the known laws of motion: my buſineſs was only to ſhew the weakneſs of the Theoriſt's arguments, and that an Earth ariſing from a *Chaos*, might have been uneven, rugged, and mountainous, notwithſtanding he aſſerted, that it muſt neceſſarily form its ſelf into a ſmooth, regular, and uniform Figure. For my part, I think it abſolutely indifferent to the queſtion, what way Mountains were made at the beginning of the World, whether by Mechanical cauſes, or by the immediate hand of God Almighty, or if by hollowing and making a channel for the Sea, the Earth was rais'd and laid upon the dry land to form Mountains; (which by the by, is not ſo ridiculous or ſo repugnant to Calculation, as the *Theoriſt* imagines) it was ſufficient to my purpoſe to ſhew, that there was no neceſſity that the face of the Primitive Earth ſhould be without Mountains.

Having thus laid open the weakneſs of the *Theoriſts* arguments, I endeavoured in the next place to ſhew, the great uſe and advantage that Mountains afforded to mankind: The *Theoriſt* aſſerted, that they did not conſiſt of any proportion of parts, that is referable to any deſign, or which had the leaſt footſteps of Art or Counſel. This I thought was a bold and ill grounded aſſertion, ſince it is certain, that they are ſo far from being placed upon the Earth without any deſign or contrivance, that they are juſtly reckon'd by the Philoſophers, amongſt the moſt uſeful, as well as the moſt ſtupendous parts of nature; without them we could have had no Rivers or Springs, which are things neceſſary to us, not only for our Commodious living, but for our very ſubſiſtence. One would think that this conſideration was a ſufficient argument to make us believe that Mountains were not great Ruins, or the rubbiſh of a broken World; but that they had been placed upon the Earth at the Creation, with a deſign that they might ſerve the Antediluvian World, with the ſame advantages and uſes they afford us in the preſent One. For it is certain, that they had Rivers and Springs as well as we, which they could not have in a ſmooth Earth, where there were no Mountains; in which, Rivers were to have their origin, no upper and higher grounds from which the water was to deſcend on the face of the Earth.

Inſtead of anſwering the argument, He makes a long declamation againſt me for aſſerting that it is impoſſible to live without Rocks and Mountains. He accuſes me for confining the Divine Omnipotence and Omniſcience, to one ſingle mode or fabrick of a World, and of thinking all the Planets caſt in the ſame mould: Who (ſays he) ever obſerv'd Mountains and Rocks in *Jupiter*, or in the remains of *Saturn?* I anſwer, who but thoſe that have obſerv'd Men or other Animals there, that muſt have Water and Rivers, as things neceſſary for their ſuſtenance?

Tho' the *Defender* is very Eloquent and Witty on this Subject, quotes *Virgil* and *Cicero*, and complains much of the narrowneſs of ſome Mens Souls, yet I think I can make it appear, that this aſſertion, as I deliver'd it, was no limitation of either the Divine Omniſcience or Omnipotence. None ever doubted but that God Almighty could make Men ſubſiſt without Mountains, Rivers, Water, Meat, or any other ſuſtenance; but yet, one may boldly ſay without confining the Divine Power, that it is naturally impoſſible for ſuch Creatures as we are, to live without thoſe things; for our Natures and Conſtitutions require them; and he muſt be without doubt in a præternatural ſtate that can live without them. The ſubject I was then handling was in Natural Philoſophy, where we are not ſo much to conſider what is abſolutely poſſible or impoſſible for God Almighty to perform, as what is agreeable or contrary to the eſtabliſh'd Laws and Rules of Nature. Thus it is naturally impoſſible that Men or other Animals of ſuch Conſtitutions as we have, can live without freſh Water, Rivers and Springs; it is contrary to the natural order of things, that theſe ſhould be without Mountains and Rocks, Upper and Lower grounds, for Water cannot naturally run upon an Horizontal Plain; and therefore we may rightly conclude,

clude, that where there are Men, there muſt be Mountains and Rivers, Upper and Lower grounds, and all other things neceſſary for life.

It is abſolutely indifferent to me, what ſort of mould the reſt of the Planets are caſt in, or what Inhabitants there are in *Jupiter*, *Saturn*, or *Mercury*, or if there are any in either of them, (which I am ſure is more than he can prove) yet I would think it no hard matter to ſhew, that it is impoſſible for us Men, or other Animals of the ſame Nature and Conſtitution that we have, to ſubſiſt in either of theſe places. For *Saturn* being very near ten times further from the Sun than we, muſt have a hundred times leſs of his influence; and the diſtance of *Mercury* from the Sun, being but one third part of our diſtance, the heat of the Sun upon that Planet muſt be nine times greater than it is upon ours, (the action of the Sun upon any ſubject being always reciprocal to the ſquare of its diſtance) both which extreams are by far too great to be endur'd by Creatures of our texture and frame of parts; and therefore we may rightly conclude, that whether they be mountainous and rocky, or have their ſurfaces ſmooth and even, yet it is impoſſible that they ſhould be Habitable by us, or Creatures of our Conſtitution; tho' yet we know not but there may be ſome ſort of Inhabitants in theſe Planets, whoſe frame and temper will ſuit with the nature and poſition of their reſpective dwellings. Thus we generally account the places that are near either of the Poles uninhabitable, becauſe no Men can dwell there; tho' it is certain, that Bears, and ſeveral other Animals, whoſe natures agree beſt with ſuch a Climate, live in theſe places; and perhaps, if ever the *Theoriſts* Earth had exiſted out of his own imagination, it might have been furniſhed with ſome ſort of Inhabitants, tho' it had been naturally impoſſible for men to have ſubſiſted there.

'Tis ſomewhat hard that a Man cannot diſſent from the *Theoriſt* and his opinions, without being taxed for narrowneſs of Spirit. But whatever the *Defender* may imagine, I am ſure, there are ſome who eſteem it as a ſign of a weak and narrow Spirit, to believe eaſily any Hypotheſis, without ſufficient evidence of its being true; which cannot be produced by the *Theoriſt* in this point. For my part, I think *Virgils* Shepherd, whom the *Defender* laughs at for not letting his imagination rove, to fancy things he had never either heard or ſeen, much wiſer than ſome *Theoriſts*, *Philoſophers*, and *Freethinkers*, who take the liberty to imagine and believe any thing, but that to which in all reaſon they ought to give a firm aſſent.

After a long declamation againſt confining the varieties of Providence to a narrow compaſs, (which I know none that do) the *Defender*

fender aſſerts, that my arguments run upon impoſſibilities; which he ſays is a nice Topick, that lies much out of our reach; and he thinks, that there may be Rivers without Mountains, notwithſtanding my reaſons. All that I can ſay to this is, that if he will not be convinced by reaſons, which he cannot or does not pretend to anſwer, he may think as he pleaſes; but I hope he will allow me the freedom to diſſent from him, till thoſe arguments be anſwer'd.

The deſign of the *4th* Chapter, was to ſhew the inconveniences that would fall upon the Earth, in caſe it had ſuch a poſture as the *Theoriſt* aſſign'd the Antediluvian World, namely an Axis perpendicular to the plane of its Orbit. To this Chapter the *Defender* makes ſome general anſwers; but firſt, according to his uſual cuſtom puts a queſtion, *viz.* If I will vouch that there are no habitable Planets in the Univerſe that have ſuch a poſture? *Jupiter* he ſays, *is known to have a perpetual Equinox, and his Axis parallel to the Axis of the Ecliptick*; here he is miſtaken, for it is not parallel to the Axis of the Ecliptick, but that of its own Orbit; *Mars* ſays he, *has little or no obliquity, and muſt we ſuppoſe that theſe Planets have no Inhabitants, or that their habitations are very bad and incommodious? Jupiter is the nobleſt Planet in the Heavens, whether we conſider its magnitude, or the number of its attendants; and if a Planet of that order and*

and dignity have ſuch a poſition to the Sun, why might not our Earth have had the ſame? What is all this to the purpoſe? Are the Inhabitants of *Jupiter* the ſame with the Inhabitants of our Earth? Or how does he know that there are any at all there? It ſeems this Gentleman is mightily in love with *Jupiter* and its Inhabitants; what degree of nobility and dignity it has obtain'd I know not, yet if he was in the moſt pleaſant country houſe in all *Jupiter*, ſo far I dare vouch, that he would not be pleas'd with his habitation, but would deſire to change and come down again to his old Rocky Mountainous Planet the Earth, and rather than ſtay there, he would be contented to live in *Lapland*.

I make no queſtion, but that the preſent poſition of *Jupiter* is very fit and well ſuited to the nature and temper of its Inhabitants, Plants, and Vegetables, (if there be any there) but what is fitting and commodious for them, may be very inconvenient for us; if we were in *Jupiter*, our blood perhaps would ſtagnate and freeze, and a Jovian if he were brought hither, would melt with heat. The inconveniences I ſhew'd, would ariſe from a perpendicular poſition of the Earths Axis to its Orbit, were only in reſpect of the Inhabitants of the Earth, and did not in the leaſt concern thoſe of *Jupiter* or *Mars*, to whom ſuch a poſture might be more convenient than any other. *Conveniencies* and *inconveniencies* are relative terms, and therefore to prove a poſition incommodious, we muſt not only conſider the conſequences of the poſition its ſelf, but the Nature and Conſtitution of thoſe Animals to which it is to be adapted; and I hope I may affirm (without any reflection on Divine Providence) that the preſent poſition in which God hath put the Earth, is more ſuitable and agreeable to the Nature and Frame of our Animals and Plants, than any other, and eſpecially than that which the *Theoriſt* aſſigns to the Primitive Earth: I am ſure that ſeveral Divines have aſſerted this, and were never thought by ſuch an aſſertion, to preſcribe to God Almighty what was beſt to be done.

I cenſur'd the *Theoriſt* indeed for enquiring into Phyſical cauſes, when there are none that can be known, and neglecting the final ones, which were the only real principles by which the queſtion was to be determin'd. For as I ſhew'd in the Examination, there is no reaſon that can be aſſign'd why the Axis of the Earth ſhould have one poſition more than another; the two motions of the Earth round the Sun, and round its own Axis, being perfectly independent on one another. God Almighty would order that which was moſt fitting and convenient for its Inhabitants; and I lay'd it down as an Axiom, that God Almighty did always chooſe ſuch poſitions as brought with them the greateſt good and advantage to the Univerſe; and therefore, ſince the oblique poſture of the Earths Axis was that which its Maker was pleas'd to chooſe, I thought it might be undoubtedly preſum'd, that it was the beſt. Proceeding on this principle, I enquir'd into the ſeveral advantages which we reaped by the preſent oblique poſition, and ſhew'd, that it was preferable to any other; and ſurely this cannot be (as the *Defender* thinks) a preſcribing to God Almighty, and telling him what is beſt to be done in this or that World. When from the Wiſdom and contrivance of what is already done, we argue that it could not have been done in a better manner.

He goes on and ſays, " That ſome men " cry out mightily againſt reaſon; and yet " none are more fond of it than they, when " they can get it on their ſide. Some men " inveigh againſt Phyſical cauſes, when o-" thers uſe them, and yet as gladly as any " make uſe of them, when they can make " them ſerve their purpoſe; and when they " cannot reach them, they deſpiſe them, and " are all for final cauſes." I never knew any that cry'd down either reaſon or Phyſical cauſes, when they were plain and obvious. But it is no wonder if there are ſome that are diſpleaſed with the reaſons and cauſes that are aſſign'd, by a ſet of Philoſophers who think they can give a Mechanical account, how an Animal, a Mountain, a Planet, or a World may be made; and yet they know not ſo much of the principles of Staticks and Geometry, as to explain the moſt common and ordinary appearances of nature, which are really explicable by Mechanical principles.

And tho' one would think that it were but reaſonable, that a man who pretends to give the Phyſical cauſes of all thoſe things, ſhould be very well skill'd in Arithmetick, Geometry, Mechanicks, and the Laws of motion; yet it generally happens, that thoſe that are leaſt acquainted with thoſe Sciences, pretend moſt to the ſolution of ſuch intricate problems, whereas they, who know them beſt, can beſt diſcover how far they may proceed upon Phyſical cauſes, how far their principles will lead them in the diſcovery of truth, and where it is that they muſt be content to be ignorant; they know that they have not ſufficient *Data* to determine ſuch problems, nor a great many others that have not the hundreth part of the difficulty of thoſe I have mentioned; and they are well pleas'd if they know their final cauſes, the uſes for which they were deſign'd by their wiſe Contriver, and never trouble themſelves with that which it is impoſſible to diſcover.

Monſieur *Hugens* I think, was at leaſt as great a Philoſpher as the *Theoriſt*, and it may be eaſily ſuppos'd, that he underſtood Mechaniſm ſomewhat better; yet he ſays, that he would be contented, and ſhould think, that he had done a great matter if he could come to the knowledge of things as they are now, never troubling himſelf about their beginning, or how they were made, knowing that to be out of the reach of humane knowledge, or even conjecture. *

* *Hugenii Coſmotheoros.*

This Author it ſeems is very angry with me, for denying, that the Primitive Earth had ſuch a poſition as the *Theoriſt* aſſign'd it; and upon that account he ſays, I follow the very doctrine of thoſe Scoffers mention'd by St. *Peter*, who ſaid, *Since the Fathers fell aſleep, all things continue as they were.* Why ſo? Did theſe Scoffers aſſert, that the Earth had never any perpendicular poſition to the Plane of the Ecliptick? and did St. *Peter* affirm the contrary? Did he ſay that the old World had a perpetual Equinox, the Equator being coincident with the Ecliptick, and its Axis parallel to the Axis of the Sun, as this Gentleman phraſes it? I can find no ſuch diſcourſe in either of his Epiſtles, nor can I ſee how ſuch a thing can be deduced from them.

A man that had no Theory, or any particular Syſtem of his own to defend, would think this the plain meaning of St. *Peter*, that there were ſome men then in being, that deny'd a Providence, or that God Almighty had any care in the Government of the World, becauſe they thought, that ſince its Creation, every thing went on ſtill in the ſame method, without any particular manifeſtation of a Providence; theſe the Apoſtle refutes, by telling them, that the World once periſhed by a Deluge of Waters, and that it was to periſh again by Fire; both which are arguments enough for a Providence, and of God's particular care of the World: this I take to be his plain meaning; except St. *Peter* be to be underſtood in an Allegorical ſenſe as well as *Moſes.*

After this general diſcourſe, he comes to a more particular conſideration of the inconveniencies alledg'd againſt the paralleliſm of the Axis of the Earth, with the Axis of the Ecliptick. One argument I brought was, that by the preſent poſition of the Earths Axis, we receiv'd more of the Suns heat, than if it had mov'd always in the Equator; and if our heat at preſent is not too great for us, (as without doubt it is not) it was a very good reaſon why the preſent poſition ſhould be eſteem'd better than that the *Theoriſt* calls a right one, wherein we ſhould not have ſo much of the Suns influence, as we have. The *Defender* thinks this is no argument againſt the Theory, for ſays he, if the heat was equal and moderate in the temperate and habitable Climates, who would deſire the extream heats of Summer? I anſwer, every one that obſerves how neceſſary the Summers heat is to the production of Vegetables, and the ripening of their ſeed, which could never be brought to any perfection, did the Sun ſhine always in the Equator, whereby the action of the Sun in our Latitude, would be little more than half of what it is at preſent in a Summers day, which therefore could never be ſufficient for the growth and perfection of Vegetables. *But* (ſays he) *how does this appear, ſuppoſing the heat conſtant? Are there no Vegetables in Jupiter which has ſtill the poſition the Theoriſt gave the Primitive Earth, and which is vaſtly further diſtant from the Sun, and by conſequence muſt have much leſs of his heat?* Whether there are Vegetables in *Jupiter*, neither the *Theoriſt* nor I can determine, for we were never there to ſee, and I believe it was never revealed to him or any body elſe, that there are.

But ſuppoſing there are vegetables there, what is that to us? Does he think them of the ſame nature and texture of parts that ours are of? Or that ours, if they were tranſplanted thither could grow and ripen in ſuch a cold ſoil, when it is certain, that they require at leaſt twenty five times a greater heat or influence from the Sun, than is in that Planet? Beſides, it is requiſite (as I ſhew'd in the Examination) that our plants and vegetables ſhould have very different degrees of heat, and therefore there muſt be ſuch changes and alterations in the ſeaſons, as are neceſſary to produce the deſign'd effect; for that heat which is requir'd for the firſt growth and vegetation of a plant, will not be ſufficient for the ripening and perfecting of the ſeed thereof, and that which is neceſſary for the bringing the ſeed to perfection would quite wither the green and tender herb; and therefore, ſince this variety of ſeaſons and alterations of heat, cannot be obtain'd either in *Jupiter* or in the *Theoriſt's* Antediluvian Earth; it is plain, that our plants could never have been brought to perfection in either of thoſe places.

But it ſeems this *Defender* is of the opinion, that the plants and vegetables of the Primitive Earth, were of a different nature and conſtitution from thoſe we have now; ſo that he muſt think, that the nature of all our plants was perfectly alter'd and chang'd, or that God Almighty having deſtroy'd the old, was pleas'd to give us a quite new ſpecies of vegetables and plants; this is a miracle that is recorded no where in Scripture, or any where elſe that I know of, and I hope he will not think us oblig'd, on his word to believe it.

I affirm'd alſo, that if the Earth had ſuch a poſition as the *Theoriſt* aſſign'd it, that the greateſt part of it wou'd not be habitable. For he himſelf acknowledges, that the Torrid Zone was uninhabitable in that Earth; and I am ſure, that the greateſt part of the two temperate Zones would not have ſufficient heat to ripen their Corn and Fruits, and conſequently would be nothing elſe but a Deſart. To this he replys with this queſtion, *How* *much leſs habitable would it be than the preſent Earth, where the open Sea which was not then, takes up half its ſurface?* I anſwer, that upon the ſame conſideration I cannot ſee how any part of it ſhould be habitable; for there being no open Sea, whoſe ſurface is expos'd to the heat of the Sun, I cannot imagine how there could be vapours enough drawn up to furniſh the Earth with Waters, Dews, and Miſts. For when it is requiſite that one half of the Earths ſurface ſhould be cover'd with water, on purpoſe to furniſh vapours enough for Rain and Rivers, how can it be ſupply'd if there were no Sea at all? Can any Man ſuppoſe that the Sun acted as freely thro' a Cruſt of an immenſe thickneſs to raiſe vapours, as it does now upon the ſurface of the open Sea? This by the way, I think is a very good argument againſt the *Theoriſt*, who aſſerted, that the Primitive Earth had no Sea.

But the *Defender* thinks, that it would be very hard, if the ſeaſons of the Year were the ſame as they are now; that the Inhabitants of the Earth ſhould be confin'd to Herbs, Fruits and Water, eſpecially in the colder Climates, where the Winters are ſo long, and the cold vehement; this he thinks, would be a moſt unmerciful impoſition. Really as hard and unmerciful as it is, there are a very conſiderable number of people in theſe cold Countries, the greateſt part of whoſe Food, is Bread, Herbs, Roots, Milk, Cheeſe, and the like; and who ſeldom taſt any Fleſh-meats. And why might not the *Antediluvians* lead the ſame kind of life? I cannot ſee that the impoſition is harder upon one than the other.

The *Defender* ſays, that the change of the poſition of the Earth's Axis, is matter of fact, and muſt be prov'd from Hiſtory. And he wiſhes the Examiner would conſult Antiquity, which would give him a more favourable opinion of the Theory as to this point. One would imagine by this, that this Gentleman had the Obſervations of ſome Antediluvian Aſtronomers to produce, who had found, that the inclination of the Earths Axis was chang'd from a perpendicular, into the preſent oblique poſture: But inſtead of thoſe, he only quotes ſome Philoſophers, that did not live within ſome thouſands of Years of the time, when this change was ſuppos'd to be made. What credit is there to be given to ſuch a Tradition? Can we imagine, that there can be any thing certainly known from Authors that liv'd ſo long after the time of this change? Eſpecially, when theſe men have ſaid a thouſand other things, that neither the *Theoriſt* nor any body elſe can believe? And yet, if we conſider what they have ſaid, we ſhall find it but very little to his purpoſe.

Diogenes, *Anaxagoras*, *Empedocles* and *Leucippus*, talked of the inclination, declination, or depreſſion of the World towards the

South, ſo that the Northern parts were rais'd higher, while the oppoſite parts ſlid towards the South. We may eaſily obſerve, that theſe Philoſophers from their way of ſpeaking, were no great Aſtronomers; it is hard to gueſs what they mean't by ſuch ſentences: But if we ſhould take their meaning as the words at firſt ſeem to import, that one Pole of the Earth was more depreſſed, or inclined towards the Sun or the Ecliptick, than the other; the thing is abſolutely falſe, for both the Poles are equally inclined to the Sun, or the Plane of the Ecliptick: (as I have ſufficiently ſhew'n in the Examination *) But whatever their meaning may be, I am ſure, it is eaſier to draw any other conſequence, than that which the *Theoriſt* has deduced from their words; nay it is probable, that they mean't the direct contrary to what he ſays they did, namely, that the Sun formerly came more towards the North, than it does at preſent, and that its diſtance from them towards the South, is now greater than it was at firſt. This, one may eaſily deduce from the words of *Leucippus* as they are quoted by *Plutarch*, Λεύκιππος παρεκπεσεῖν τὴν γῆν εἰς τὰ μεσημβρινὰ μέρη διὰ τὴν ἐν τοῖς μεσημβρινοῖς ἀραιότητα ἅτε δὴ πεπηγότων τῶν βορείων διὰ τὸ καταψύχθαι τοῖς κρυμοῖς, τῶν δὲ ἀντιθέτων πεπυρωμένων. *Leucippus terram in partes auſtrinas prolabi putat ob iſtarum raritatem, quippe gelu concretis partibus Septentrionalibus, dum oppoſitæ interim ardent.* So that it ſeems

* Pages 66, 67, 68.

ſeems according to *Leucippus*, the Sun acted more ſtrongly upon the Northern Hemiſphere formerly, than it does now, and that it does not now come ſo near the Zenith of thoſe that live towards the North-Pole, as it did at firſt; whereby the waters of theſe Northern parts are quite frozen and turn'd into Ice, while the parts toward the South, (being on the contrary expos'd to too great heat) are burnt and ſcorch't: that is, the declination of the Ecliptick from the Equator (at leaſt toward the North) was greater formerly than now.

Thus, we ſee how little favourable theſe Philoſophers are to the *Theoriſt*'s opinion; and that their ſentiments are at leaſt as capable of being brought as arguments againſt him as for him.

It is true, that *Plato* ſpeaks of *ἀναρμοστία ϗ ἀνομωλία*, a diſharmony or irregularity in the motions of the Heavens, that was not under the reign of *Saturn*. But this ſignifies nothing to the *Theoriſt*'s purpoſe; for if we ſhould admit of his poſition, yet ſtill there would be the ſame apparent irregularities in the motions of the Heavens. For the Planets would not in that caſe move uniformly round the Earth, but would have their directions, ſtations, and retrogradations, as they have at preſent; and none of them but the Sun would move preciſely in the Equator. The other quotation the *Theoriſt* brings from *Plato*, is nothing to his purpoſe, and is alledg'd by another *Theoriſt*, to prove a quite contrary Hypotheſis.

Theſe are the teſtimonies the *Theoriſt* has produced from the old Philoſophers, to prove the truth of his Hypotheſis, which in my mind, if it were not for pomp and ſhow, he might have as well let alone; for I think, they will prove any thing elſe juſt as well as what he deſign'd. If theſe Gentlemen had ſpoke of a coincidence that was at firſt between the Equator and the Ecliptick, or of the Axis of the Earth or World, being perpendicular to the Ecliptick, or if they had ſaid, that the Sun at firſt mov'd always in the Equator, or that the days and nights throughout the whole Year were equal, (which might have been eaſily ſaid and much eaſier underſtood, than what they have deliver'd) they had ſpoke ſomething to his purpoſe; but inſtead of this, we have ſome dark ſentences, whoſe real meaning it is hard to gueſs at, and ſome of which ſeem to be ſo far from proving the *Theoriſts* poſition, that they ſeem rather to infer the contrary, and that the Suns declination was greater formerly than now. Sure a man muſt be put to a hard ſhift for ancient Traditions, that will bring ſuch Teſtimonies to prove his point.

But the *Defender* alledges, that theſe places will at leaſt prove that there was ſome change made in the ſtate of nature formerly; and if I will not allow that which the *Theoriſt* has aſſign'd, I muſt ſhew ſome other which will have the ſame effects. Why ſo? I hope he does not ſuppoſe me to be like ſome Philoſophers, that think themſelves oblig'd to give an account of every appearance, and fancy it a ſtain in their reputation and honour, to be ignorant in any thing: If he ſuppoſes ſuch a thing, I aſſure him he is much miſtaken; for I am ſenſible that there are more things which neither he nor I know than what we do. The Poets are the next witneſſes the *Theoriſt* produces to prove the truth of his poſition: And theſe indeed talk of the continual ſpring and verdure of the Earth that was under the reign of *Saturn.* We know the Fable of the four Ages, of which the Golden was the firſt and beſt; in it they fancy'd every thing that was pleaſant and delightful, and therefore they remov'd from it all extremities of heat and cold; and upon that account they would allow neither of Summer or Winter, but a perpetual Spring wherein every thing was freſh and blooming. But it is eaſie to perceive that all this was a figment: For when they or other Writers were to deſcribe any pleaſant places, they continually endow'd them with ſuch qualities. Thus *Homer* deſcribes the *Elyſian* Fields as he is quoted by the *Theoriſt*, *Archæol. pag.* 263. and *Virgil* ſuppoſes that there were fine green Meadows there. This Poet alſo in ſumming up the praiſes of *Italy* and prefering it before all other Countries,

tries, among other excellent qualities he endows it with a perpetual Spring,

Hic ver aſſiduum atque alienis menſibus æſtas.
Virg. Georg. Lib. II.

Thus *Plutarch* deſcribes the fortunate Iſlands, and *Pliny* the *Loca Hyperborea.* From which we may clearly ſee, that there was no other foundation for any ſuch aſſertion, but the fancy of the contrivers, who were to ſet forth their places of happineſs to the beſt advantage.

But the *Defender* thinks, that if none of thoſe he has mention'd will paſs for ſufficient witneſſes of the matter of fact; yet I will certainly allow of the Teſtimonies of ſome ancient Aſtronomers, who have ſaid ſomething relating to this matter. Well, let us ſee what they ſay. He quotes *Baptiſta Mantuanus* from the *Archæolog.* whoſe words are theſe. *Erant illis (nempe Antediluvianis) ut Aſtronomiâ & experimento conſtat, Cœli propitiores; volunt namque Aſtronomi duos eſſe Zodiacos, unum in nona ſphæra, alterum in octava, quod firmamentum vocant; & initio rerum & temporum ſic à Deo diſpoſitos ut Aries Arieti, Taurus Tauro, Gemini Geminis jungeretur, & amborum coeuntibus in unum viribus fortior fiebat in terris influxus, unde & herbas tunc ſalubriores, & fructus terræ meliores.* As alſo *Petrus Aponenſis* in his *Conciliator Diff.* has theſe words, *Cum capita Zodiaci mobilis & immobilis ordinate & directe concurrebant, tum virtus perfectiori modo, à primo principio*

principio per medias cauſas taliter ordinatas fortiori modo imprimebatur in iſta inferiora, cum cauſæ tunc ſibi invicem correſpondebant.

Theſe Teſtimonies I own do ſufficiently convince me, not that the *Theoriſt*'s poſition of the Primitive Earth was the true one; but that the *Defender* who has alledg'd them to prove his point does not underſtand them. For he could not have quoted any thing that was leſs to his purpoſe than they are. I know not what skill this Author has in the new Aſtronomy; but I am ſure he does not underſtand it if it be put into an old faſhion'd dreſs. No doubt he thought that theſe Authors mean't by ſuch words that at firſt the Equator and Ecliptick were coincident; when they never dream't of any ſuch thing.

They as their own words informs us, ſuppoſe with all the old Aſtronomers two Zodiacks, the one of which is exactly placed under the other, and (the uppermoſt being immoveable) the loweſt in which the fixed Stars are placed moves exactly under it, and performs its courſe from Weſt to Eaſt, according to ſome in the ſpace of 25000 Years. At firſt theſe two Circles had the ſame beginning, the Conſtellation *Aries* being exactly in the ſign of the Ecliptick of the ſame name, and the Conſtellation *Taurus* was exactly in the ſign *Taurus*; the Stars alſo that make up the figure of *Gemini*, were exactly under the ſign *Gemini* of the immoveable Zodiack, and ſo in the reſt. By which theſe Aſtrological Gentlemen thought, that both their forces being united, their efficacy and vertue upon the Earth would be very ſtrong. But now that the moveable Zodiack has mov'd, theſe two Circles have not the ſame beginning, and the Stars that make up the figure of *Aries*, are not in the ſign *Aries* but in *Taurus*, and thoſe Stars which compoſe the ſign of *Taurus*, are no more in *Taurus* but in *Gemini*, ſo the Stars of *Gemini* are got into *Cancer*, and thoſe of *Cancer* into *Leo*, &c. as may plainly be ſeen on any Cœleſtial Globe. Which they ſuppoſe to be perform'd by the motion of the eighth Sphere or the moveable Zodiack, of which all the old Aſtronomers ſpeak, whom if he pleaſes he may conſult; particularly he may read *Clavius*'s Notes on *Sacroboſco de Sphæra*, which is as common and as good a Book as he can find on the ſubject.

But it ſeems the *Defender* thinks that this would appear more to his purpoſe, if the old faſhion'd diſguiſe were taken off, and the buſineſs apply'd to the true Syſtem of the Heavens. Well let us ſee if it is ſo. The new Aſtronomers ſuppoſe that the Stars are immoveable, and that the Earth turns round the Sun, ſo that its Axis makes always the acute Angle of $66\frac{1}{2}^{\circ}$ with the Plane of its Orbit: if this Axis were perfectly directed to the ſame point of the Heavens, or mov'd always preciſely parallel to its ſelf, then the fixed Stars would ſeem to have no other motion but the diurnal: But becauſe the Earths Axis varies a little from an exact paralleliſm, and does not preciſely point to the ſame Star when it is in the ſame place of its Orbit but makes a ſmall Angle with a line that obtains the poſition it had formerly in the ſame place; hence it happens that the Equinoctial points or the common ſection of the Equator and the Ecliptick, retrocede or move backwards from Eaſt to Weſt; and this is that which the Aſtronomers call the preceſſion of the Equinox, by which the fixed Stars ſeem to move from the Weſt to the Eaſt with a very ſlow motion, and the Conſtellation *Aries* which at firſt was in the ſign *Aries*, has now got into *Taurus*, and *Taurus* has ſeem'd to move into *Gemini*, *Gemini* into *Cancer*, &c. From hence it appears, that according either to the old or new Aſtronomers, the fixed Stars change their Longitude daily but not their Latitude, and they have always ſuppos'd that the Axis of the World has kept ſtill the ſame Angle with the Plane of the Ecliptick. I will now leave it to any indifferent Reader, or even to the *Theoriſt* and his *Defender* to judge, if theſe quotations ſignify any thing to the purpoſe, or if they are not ſtronger arguments againſt the *Theoriſt*'s poſition than for it.

Since the *Defender* has adviſ'd me to conſult Antiquity, I ſuppoſe it will not be amiſs to alledge the teſtimony of a very ancient Philoſopher, whoſe authority ought at leaſt to be as great as *Leucippus*'s, *Anaxagoras*'s, *Empedocles*'s, or even *Plato*'s I mean the Divinely inſpir'd *Moſes*, who is the moſt ancient Writer that is now extant, and the only one who gives us an account of the ſtate and condition of the Primitive World, of which the Philoſophers adduced by the *Theoriſt* were altogether ignorant; in his Writings there is not one word of the coincidence of the Ecliptick and the Equator, or of the perpetual Equinox and Spring that was obſerv'd in the Primitive Earth. *Moſes* ſuppoſes no ſuch thing but rather the contrary, for in giving an account of the Creation he tells us, that *God ſaid let there be lights in the firmament of the Heavens to divide the day from the night, and let them be for ſigns and for ſeaſons, and for days, amd for years*; and from this it is obſervable, that *Moſes* ſuppoſes that there were different ſeaſons from the very Creation, and that their variety proceeded from the different motion of the Heavenly bodies, and more particularly of the Sun, whereas if the *Theoriſt*'s Hypotheſis had been true, the motion of the Sun could have made no variety of ſeaſons; but the Year would have remain'd with the ſame face and tenour, having but one continued ſeaſon. Thus it is evident, that the *Theoriſts* ſuppoſition in this matter, is directly contrary to that of *Moſes*, and I think that his teſtimony ought to be of greater force with any candid Reader, even ſuppoſing that he had no Divine Inſpiration, than any thing that could have been ſaid by ſuch Philoſophers as the *Theoriſt* has brought, who lived not till many hundred years after *Moſes*'s time.

After this diſpute about matter of fact, our Author comes to defend the *Theoriſt*'s reaſon he gave for the Antediluvian poſition of the Earth. It is ſaid in the Theory, that the Earth being an uniform and regular Body, having its Center of Gravity the ſame with its Center of Magnitude, it would naturally take an even and parallel poſition with the Axis of its Orbit. In reply to this I told him, that it was demonſtrated by the Writers of *Hydroſtaticks*, that a Sphere (or indeed any other body) whoſe Center of Gravity coincides with its Center of Magnitude, if put in a fluid of the ſame intenſive Gravity with its ſelf, will be indifferent to any poſition given. Our *Defender's* anſwer to this, is, *That ſuch a thing may be*, that is, for ought that he knows it may be ſo, *if the Sphere was reſting*; *but if it was turned about its Axis and the Axis of the fluid, it would certainly take a poſition parallel to the Axis of the fluid.* I wonder who aſſur'd him of this; I can ſcarce believe he had any Letters from *Kenſington* or any where elſe for it; otherwiſe he would have produced them as the grounds of his certainty. Well, tho' he is very ſure of his point, yet perhaps it may not be true, and therefore we will enquire if it is ſo or not. [*Fig.* 12. *Plate* VI.] Let A B C repreſent an Arch of the Ecliptick, or of any Circle parallel to it; D E F any Circle in the Earth leſſer or greater in the ſame Plane with the Circle A B C, let H be the point where the ſtream of the fluid falls perpendicularly upon the Circle D H E F and take any two Arches D H and E H equal. The direction of the particles of the fluid falling upon the point E is G E, and of thoſe which fall upon D is I D, ſo that the lines G E, A H, and I D, are parallel. Becauſe the particles which move from G to E come obliquely on the point E, part of their force will be ſpent in carrying or driving the Circle forward, and part of it will be employ'd in turning the Circle round an Axis perpendicular to the Plane A B C from H, to E and F. So that the total force of the particles is to that part of it which is uſed in turning the Circle round, as the ſquare of the Radius to the Rectangle, contain'd between the Sine of the Arch H E and its Coſine; after the ſame manner part of the force of the particles which move from I to D and fall upon the point D will be ſpent in turning the Circle round from H D to L, ſo that the total force of the particles which ruſh upon D will be to the force by which they endeavour to turn the Circle round as the ſquare of the Radius is to the Rectangle contain'd between the

Plate VI.

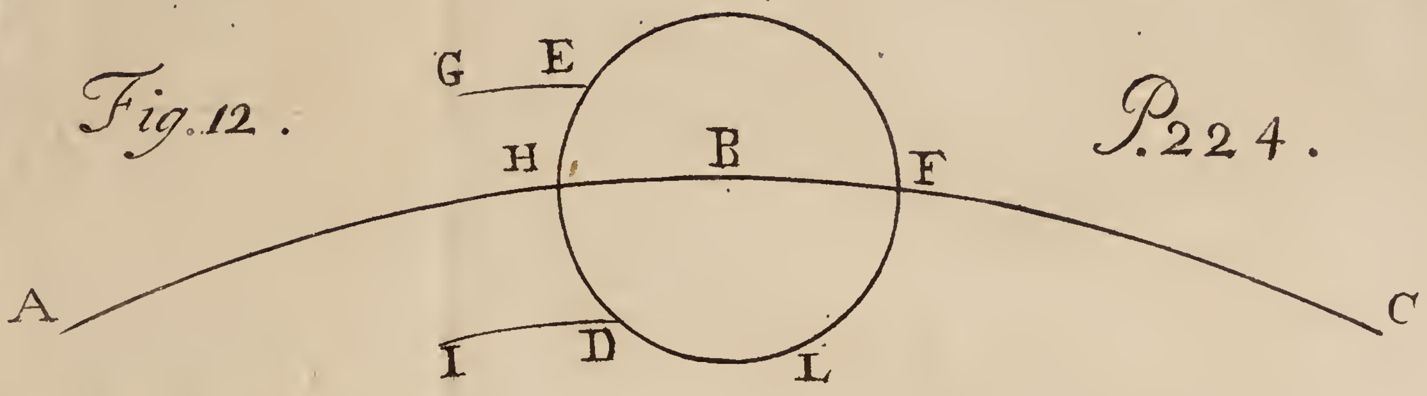


Fig. 12. P. 224.

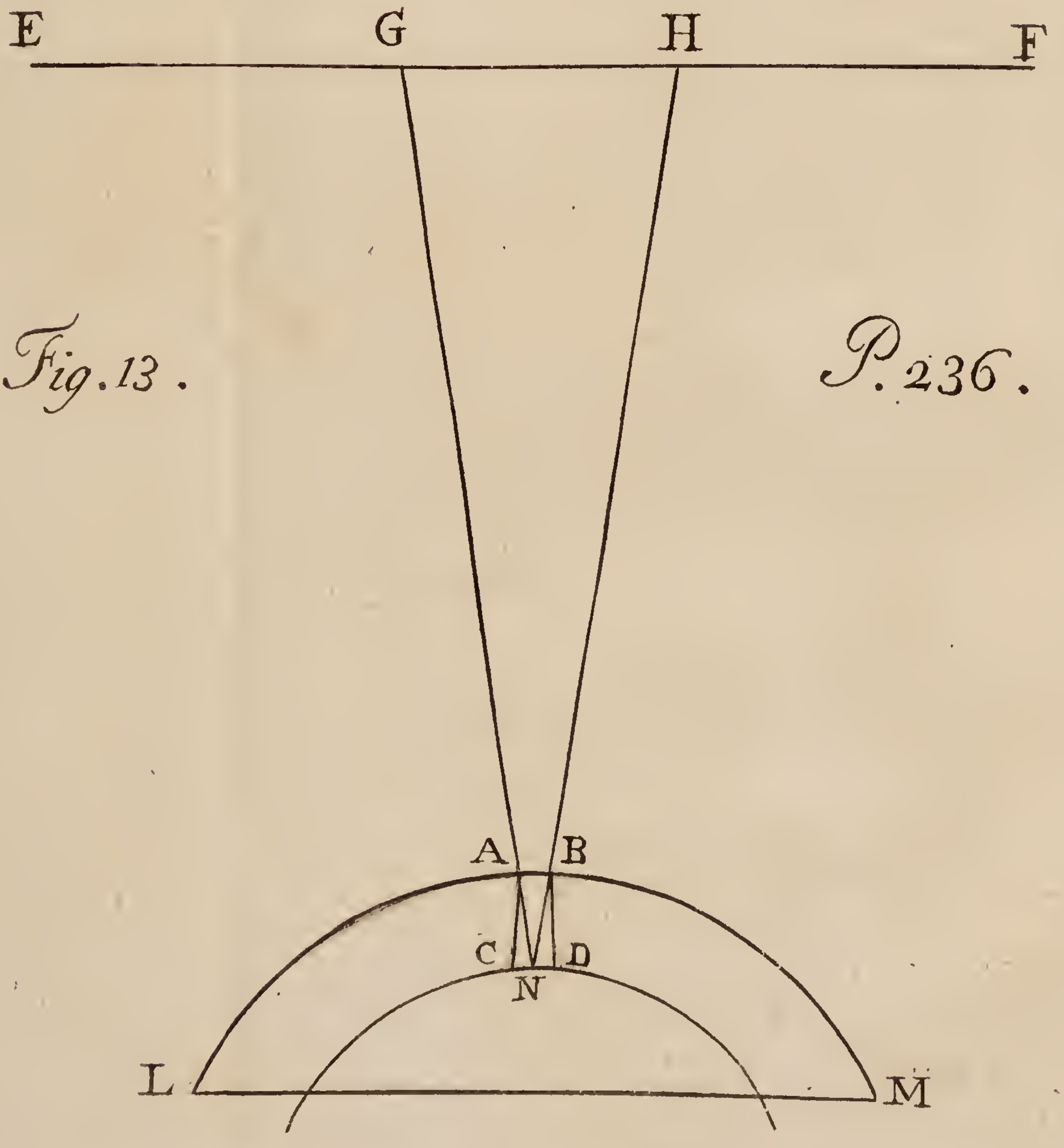


Fig. 13. P. 236.

the Sine of the Arch D H and its Coſine: and becauſe the Arches H E, H D, are equal, it is plain the force of the ſtreams of the fluid particles whereby they will endeavour to turn the Circle round its Axis muſt alſo be equal; but they being contrary one to another will hinder the action of each other in turning the Circle round. Juſt ſo whatever is the force of the particles of the fluid which falls upon any point in turning the Circle round from H by E and F there is another force which is equal to it, and endeavours to move the Circle the contrary way from H to D and L, which two forces will hinder each others effect in turning the Circle round; the ſame thing is true of all the Circles that are parallel to the Ecliptick; and therefore the motion of the fluid has no ſort of effect upon the Sphere to turn it round an Axis perpendicular to the Axis of the Ecliptick. But notwithſtanding its own motion and the motion of the fluid, it will remain indifferent to move round any of its Diameters as an Axis, the fluid having no effect in making it turn round one Diameter more than another.

I found fault with the *Theoriſt* for ſaying the Earth was inclin'd to the Ecliptick, it being impoſſible to conceive how a Sphere can be inclin'd to a Plane, paſſing thro' its Center as the Ecliptick does thro' the Center of the Earth. The *Defender* endeavours to excuſe himſelf in this matter, telling us, it is the expreſſion of the ancient Philoſophers, tho' he thinks it may be properly called an obliquation.

I would not have him raiſe a ſcandal on the ancient Philoſophers without good grounds, which I ſcarce believe he has for his aſſertion; yet if they ſaid any ſuch thing, I did not think that the *Theoriſt* was ſo great an admirer of the old Philoſophers, that in complaiſance to them he would have ſpoken nonſenſe.

He tells me that *Situs rectus* is another expreſſion I quarrel with; really tho' perhaps it is not very proper, I do not remember that I any where found fault with it; and he might have ſpared himſelf the trouble of citing a paſſage out of *Hugens* nothing to his purpoſe, for *Monſ. Hugens* who always ſpeaks ſenſe, does not ſay that *Jupiter himſelf* but that his *Axis* is right to the Plane of his Orbit. But tho' the *Defender* endeavours to excuſe the *Theoriſt* for his improprieties of expreſſion, yet he paſſes over without any excuſe the great error which he made in aſſigning the cauſe of the ſuppos'd change of poſition, which the Earths Axis ſuffer'd at the Deluge.

The *Theoriſt* ſaid, that at firſt the Earth was equally pois'd, and therefore he thought it muſt keep its Axis ſteady and parallel to the Axis of the Ecliptick; but at the Deluge it loſt the Equilibration as he calls it, and one end or Pole becoming heavier than the other, the heavieſt end inclin'd towards the

Sun, in which ſaid poſture he ſays the Earth has ever ſince continu'd. I muſt acknowledge that I could not read this without ſome indignation, and am aſham'd to find one who pretends to give a Mechanical account of the Creation, and of the changes the World has ſince underwent, diſcourſe in ſo crude a manner, that it may clearly be ſeen that he has not ſo much as a common inſight into that learning, which would have taught him the preſent poſture of the Earth and its Axis. For I ſhew'd in the Examination, that every one that underſtood the Elements of the new Aſtronomy, knew perfectly that one Pole of the Earth was not more inclin'd to the Sun than another; and that if ſuch a change had really happen'd to the Earth, *viz.* that one Pole of it had become heavier than the other, that Pole had always inclin'd to the Sun and made a perpetual Summer in all the places of the Hemiſphere, while the other enjoy'd a continual Winter; and becauſe no ſuch thing happen'd, but both the Poles were equally inclin'd to the Sun, it was a demonſtration that no ſuch change of Gravitation happen'd to the Earth. The *Defender* is pleas'd to take no notice of this argument, and yet has the confidence to aſſert that, he thinks the *Theoriſt's* reaſons very probable for the cauſes of the ſuppos'd change of the poſition of the Earths Axis.

But the *Theoriſt* in the laſt Edition of his *Engliſh Theory*, ſeems to have found out another cauſe which he thinks in ſome meaſure contributed to the change of the Earth's poſition, and that it is the change of the Direction of the Magnetick particles, which he ſays followed upon the diſſolution of the Earth. But before we can know if this would do, we muſt diſcover what theſe Magnetick particles are, what their direction is, what it was before the Deluge, what afterwards, how it came to be chang'd, and how this change produced a change in the poſition of the Earths Axis. And till he pretend to give a Mechanical account of theſe things, he can no more expect a diſtinct anſwer from me, than if he had ſaid all this had been done by ſome occult quality. For looſe and general Harangues about Effluviums, Particles, ſubtle Matter, Modes and Motions, ſignify very little more to explain Nature, than the Qualities and Attractions of the old Philoſophers, (whom the *Theoriſt* upon this account ſo often derides) 'tis indeed but another ſort of Cant, and affords as little ſatisfaction to the mind. Before I proceed any further, I muſt own I was miſtaken when I ſaid, that the Axis of *Jupiter* was oblique to the Plane of its Orbit. In reading of *Hugen's Syſtema Saturninum*, I remember'd that this poſition was affirm'd of *Saturn*, and I thought that I had read there that *Jupiter* had a like poſition, which I wrote down without conſulting the Book it ſelf, which I had not then by me.

The *Defender* has miſtaken my meaning, when he imagines I ſaid, that according to to the *Theoriſt* both *Jupiter* and *Saturn* were Antediluvian Planets; for the particle *whom* in the parentheſis, refers only to *Jupiter*, tho' in the mean time I own the expreſſion is ambiguous, and may refer to both.

At laſt the *Defender* comes to give us a ſhort account of the *Theoriſt*'s Creed as to this point, which he conceives to be thus, *The Earth was at firſt in an even and parallel poſture with the Axis of the Sun, or* (as he explains himſelf in the 2*d.* Page of his Reflections) *its Axis was not oblique to the Axis of the Sun or the Ecliptick, but lay parallel with the Axis of the Sun, and perpendicular to the Plane of the Ecliptick. Then the Earth had a perpetual Equinox and unity of Seaſons, and the Heavens and fixed Stars moved uniformly and concentrically with the Earth; but when the Earth changed its poſture into that which it has now, it had the poſition of its Axis changed into a paralleliſm with the Axis of the Equator, and the Heavens ſeem'd to turn round upon another Axis different from thoſe of the Sun or the Earth.* I muſt beg this Author's leave to ſay, that he has groſly miſrepreſented the *Theoriſt*, who, ſo far as I can diſcover never expreſſed himſelf to any ſuch purpoſe. I thought that there were already errors enough in this Theory, ſo that he needed not have made them more by falſe miſrepreſentations. For I can find no ſuch thing in either the *Latin* or *Engliſh* Theory, as that the Axis of the Earth was ever parallel to the Axis of the Sun. It is ſaid indeed that the Axis of the Earth was parallel to the Axis of the Ecliptick, and perpendicular to its Plane, and this I muſt own is falſe; but were it true, yet what the *Defender* advances upon it would be impoſſible, *viz.* that the Axis of the Earth would alſo be parallel to the Axis of the Sun, for ſince the Axis of the Sun is not perpendicular, but ſtands at oblique Angles upon the Plane of the Ecliptick, as is evident from *Gallileo* in his Book *de Macchie Solari*, *Scheiners Roſa Urſina*, *Kepler*, Monſ. *Caſſini*, Mr. *Flamſtead*, and moſt of the Aſtronomers who have wrote upon this ſubject: but even his own Maſter *Des Cartes*, (from whom he ſeems as induſtriouſly to diſſent when he is in the right, as he is always ſure to tranſcribe him when he is in the wrong) tells us, that the Axis of the Sun makes an Angle of ſeven degrees with the Axis of the Ecliptick: If I ſay what theſe Learned Men have obſerv'd be true, then either the propoſition advanced by the *Defender*, or the 8*th.* of the 11*th.* of *Euclid* muſt be falſe. This Author alſo tells us, that before the Deluge (the Earth having a right poſition) the Heavens with the fixed Stars mov'd or ſeem'd to move concentrically with the Earth. I cannot ſuppoſe that he mean't by this, that all the fixed Stars ſeem'd to turn round the Earth in Circles, that have the Axis of the Earth for their Axis, for they do ſo now, and muſt do ſo whatever poſition the Earth obtains, if the motions of the Stars be only apparent and cauſed by the real rotation of the Earth round its Axis.

I fancy therefore that by a concentrical motion he means, (if he means any thing) that which is perform'd in a Circle which has the ſame Centre that the Earth has, (as the word implys) and I am confirm'd in the opinion, that this or ſome other ſtrange thing is mean't by this word, becauſe the *Theoriſt* in his *Archæolog.* aſſerts, that in his Primitive Earth all its Inhabitants would be *Aſcii*, that is, they would have no ſhadow at twelve of the Clock, or they would have the Sun vertical to them at that time. This I dare venture to ſay is impoſſible in this or any other of the numberleſs Worlds, that the *Defender* dreams of among the fixed Stars, unleſs the Sun can be multiply'd or made to appear at many different places at the ſame time. For every one that ever read any one Page about the firſt principles of Geography knows, that all thoſe who live under the ſame Meridian have twelve of the Clock at the ſame time, and conſequently if the Sun were at twelve of the Clock vertical to all thoſe who live under it, he muſt be in every point of that Meridian at the ſame time. I leave the Reader to judge if theſe men whoſe notions in Aſtronomy and Geography are ſo diſtinct and clear, are not very capable of making Theories and diſcourſes about the poſture of the Primitive Earth, and the poſition of its Axis? They ſhould be adviſ'd before ever they venture again to make another Theory, or defend this, to learn ſomething of the common principles of the Sphere. Perhaps they think them too common and eaſy, and ſuch as every body may know that will be at the pains to ſtudy, and therefore they deſpiſe them, and go upon higher attempts to find out ſomething that no body elſe can diſcover; as the method how the Earth was made, and what was the ſtate and condition of the Antediluvian World. But for my part I would rather be quite ignorant of the poſture of the Primitive Earth and the poſition of its Axis, than not know the common principles of Aſtronomy and the doctrine of the Sphere. I am ſure if this Author had ſpent but half the time upon this ſubject that he has done upon the Theory, he might have avoided many abſurdities, and would not have talk't of the Axis of the Earth being chang'd into a paralleliſm with the Axis of the Equator, and the Heavens ſeeming to turn round upon an Axis different from that of the Earth. For it is well known, that the apparent motion of the Heavens is about the Axis of the Earth, and that the Axis of the Equator is the ſame with the Earths Axis, and it is impoſſible that they could ever have been diſtinct.

It ſeems this *Defender's* acquaintance is only with the Antediluvian World; for one would think by his way of Writing, that he knew nothing at all of this Worlds poſition or motions. His diſcourſe and terms are ſo odd and ſtrange, that I ſometimes believe they were terms that were uſed by the Antediluvian Fathers; for I am ſure they cannot be accommodated to the preſent mode and manner of ſpeaking.

The deſign of the fifth Chapter of the Examination is, to conſider the *Theoriſt's* method of forming Rivers in the Primitive Earth; which, according to him were furniſhed with Vapours drawn from the Abyſs thro' the Cruſt by the heat of the Sun. Againſt this I objected that from thence it would follow, that there could be no Rivers for a conſiderable time after the firſt Creation of the Earth. For one would think that it muſt neceſſarily require ſome time before the Suns heat could penetrate thro' a thick Cruſt to raiſe vapours from the Abyſs; all which time the Inhabitants of the Earth muſt be without Rivers. The *Defender* thinks this objection may be anſwered by ſaying, that the Earth was at firſt ſoft and moiſt, and therefore could not but furniſh ſtore of vapours to ſupply the Rivers. But this is nothing but a ſhift; for if we bring it to a Calculation, we ſhall find the cauſe no ways anſwerable to the effect.

I ſhew'd in the Examination, that the quantity of water evacuated by all the Rivers every Year, was at leaſt equal to 263080 Cubical Miles; now if we allow no more Rivers in the Primitive Earth than there are now in ours, (whereas in our proportion to the ſurface of the Land they ought to be double) ſo many Cubical Miles of water will likewiſe be neceſſary every Year to ſupply the Primitive Rivers; and if we admit that the Sun had penetrated the thick Cruſt in the ſpace of ten Years (which is a time little enough in all reaſon for ſuch an effect) the quantity of water that would be neceſſary to ſupply the Rivers for ſuch a time, muſt not be leſs than 263080 Cubical Miles; which is ſuch a quantity as would make the Earth very ſoft and moiſt indeed: But it would be much rather a Marſh and Mire than an habitable Earth.

I objected alſo that it was impoſſible that the Rays of the Sun could ever reach thro' a vaſt thick Cruſt, ſo as to be able to raiſe vapours from the Abyſs. Or if we ſhould ſuppoſe that it did raiſe them, yet it could not do it in ſuch a quantity as would be requiſite to furniſh the Antediluvian Rivers. For who can imagine that the Sun could act as freely upon the Abyſs, as it does now upon the open Sea? Whoſe ſurface is expos'd to the continal heat of the Sun, whereas the Abyſs was encloſ'd by a thick Cruſtation, in which were all the Materials of Earth, Sand, Clay, Gravel, Ores, and Metalline ſubſtances? And ſeeing the Sea as it is now laid open to the action of the Sun, is but juſt ſufficient to ſupply us with Rain and Vapours; does it not ſeem a thing againſt common ſenſe to ſuppoſe that the Abyſs encloſ'd with a thick ſhell could have ſent out a quantity of Vapours great enough for ſuch an effect?

But I paſſed from theſe general words, and reduced the matter to Calculation; where I ſhew'd, that if we allow'd the mouths of all the Pores, Cracks and Chaps, thro' which the Sun muſt have acted on the Abyſs to have been $\frac{1}{10000}$ part of the Earth's ſurface; there would then have been five thouſand times leſs Vapours to have ſerv'd twice as great a quantity of dry Land; and therefore that in a Country as big as *Britain*, there would not have been ſo much as one River, nor ſo much Rain in a Year as does now fall in a day. All the anſwer the *Defender* makes to this, is, that I ſuppoſe great cracks and pitts thro' which the Vapours aſcended, whoſe dimenſions and capacities I examine at pleaſure, whereas he does not find that the *Theoriſt* makes any mention of theſe Cracks for that purpoſe; The only queſtion is, whether the heat of the Sun could reach ſo low as the Abyſs, when the Earth was dry'd and its

Pores enlarged. Here he is miſtaken, this is not the only queſtion; for there is another material one beſides, *viz.* That ſuppoſing the heat of the Sun had reached the Abyſs, whether there could have been vapours enough extracted from it to furniſh the Earth. And I think I have prov'd that there could not.

But it ſeems he will not allow of the Calculation, becauſe it ſuppoſes, that the Sun acted thro' large cracks, fiſſures and chaps, which he ſays the *Theoriſt* did not mention for any ſuch purpoſe: but he will have the Sun to have acted only thro' the Pores of the Earth. Well, let us grant his ſuppoſition, that the Sun did not act thro' large cracks and fiſſures, (which I thought would beſt ſerve his deſign) but only thro' the Pores of the Earth; and we will ſee how much the *Theoriſt* will gain by it.

Let us therefore conſider one of theſe Pores, which we will ſuppoſe to be one inch Diameter; (and I think it a good large one) let us alſo ſuppoſe that the Cruſt from its ſurface to the Abyſs is but one Mile thick, which is but a very moderate ſuppoſition, as in the figure, [*Fig.* 13. *Plate* VI.] where A B repreſents the mouth of one of theſe Pores, A C the thickneſs of the Cruſt, C N D the ſurface of the Abyſs, E G H F the Diameter of the Sun; G H is the Diameter of that part of the Sun which can ſhine all at once upon the point N, which is midway betwixt C and D, becauſe AC is to CN as 5000 to half an inch, that is, as 120000 to 1 the Angle CAN will be ſomewhat leſs than two ſeconds; and therefore the double of it which is the Angle ANB or GNH will be leſs than four ſeconds; but the whole Diameter of the Sun ſubtends an Angle of 30 minutes, therefore EF the Diameter of the Sun, is to GH the Diameter of that part which ſhines thro' the Pore AB as 30 minutes are to four ſeconds, that is, as 1800 to 4 or 450 to 1. But Circles are to one another as the ſquares of their Diameters, and conſequently the Disk of the Sun which ſhines all at once upon our Sea, is to that part of it which ſhines upon the Abyſs thro' its Pores, as the ſquare of 450 to 1, that is, as 202500 to 1; and therefore the action of the Sun upon the ſurface of the Abyſs, would not be the two hundred thouſandth part of what it is upon the ſurface of our new Ocean. But 'tis plain by the Figure, that the Sun could not ſhine the ten thouſandth part of the time upon the Abyſs, that it can do upon the Sea. And therefore if we diminiſh its action alſo upon that account, we ſhall find that the heat of the Sun upon the Abyſs, would not be the ten millioneth part of what is upon the preſent Sea; and the vapours raiſed from the Abyſs, would be leſs than thoſe which are raiſed from the Sea very near in the ſame proportion.

tion. Has not the *Theoriſt* now mended his cauſe mightily by this anſwer of his *Defenders*, which has made the argument againſt him much ſtronger than it was before?

I am accuſed of dealing unfairly with the *Theoriſt*, when I make him ſuppoſe that Mountains make way for the motion and dilatation of vapours. If this is unfair dealing, I cannot tell what will be fair; for the *Theoriſt* himſelf has expreſly ſaid ſo, in his Book II. Chap. 5. Parag. 4. of the *Engliſh Theory*. Where, ſpeaking of the North and South parts of the World, which he ſays draw the vapours to them; his words are theſe, *The cold of thoſe parts attracting them, as we call it, that is making way to their motion and dilatation without reſiſtance, as Mountains and cold places uſually draw vapours from the warmer.* Tho' I quoted theſe words in the Examination, yet the *Defender* aſſures us, that the *Theoriſt* ſuppoſes no ſuch thing. It ſeems then that he can ſay one thing, and ſuppoſe another. If ſo, I wiſh the *Defender* would give us two Catalogues, one of thoſe things which he ſays and ſuppoſes to be true, and another of thoſe things he ſays without ſuppoſing them to be true; I hope in this laſt we ſhould find what is ſaid in the *7th. 8th.* and *9th.* Capters of the *Archæologiæ*, concerning the *Moſaical* account of the Formation of the World, its Primitive State, and the Fall of Man.

Our next diſpute is about the courſe of the vapours. The *Theoriſt* aſſerted, that it would be towards North and South. Now I prov'd that it would be from Eaſt to Weſt; becauſe I demonſtrated, that there muſt be a continual wind blowing that way, in an Earth where there were no Mountains to change the direction of the wind; juſt as it is now in the *Atlantick* and *Pacifick* Oceans. And ſeeing the vapours ſwim in an Air of the ſame intenſive gravity with them themſelves, it is demonſtrable that they muſt follow the motion of that Air, and be likewiſe carry'd from Eaſt to Weſt. The *Defender* grants, that their motion would be at firſt that way; But (ſays he) the queſtion here is, where they would be condenſed or where they would fall. I think it does not ſignify any thing where they fall; for I am ſure they would not fall or be condenſed in a place to which they were never carry'd, that is, towards either of the Poles.

The *Theoriſt* was of the opinion that the cold in the North and South parts attracted the vapours thither, that is, (as he explains it) made way for their motion and dilatation. But becauſe I ſhew'd that this method ſavoured a little of abſurdity, our Theory-mender ſays, that the vapours were diverted towards North and South, by an impulſe of new vapours. This opinion ſeems to me to be as unnatural as the other, for if the vapours were crowded on one another by their mutual impulſes, they would condenſe one another, and fall down in the places where they were crowded.

I am ſure it is impoſſible, that an atome of vapour however impell'd, ſhould make its way thro' an Atmoſphere of the ſame gravity with its ſelf, for ſome thouſands of Miles towards either of the Poles; when a ſtone which has ſome thouſand times more denſity than vapours, and conſequently ſome thouſands of times alſo more force to break the reſiſtance of the medium, if it were to move to Eternity in the Air, yet it would never make any conſiderable way in the medium, by reaſon of the continual loſs of its motion.

It ſeems to contradict our ſenſes to ſuppoſe, that vapours can move thro' the Air without ſuffering ſuch a reſiſtance as muſt condenſe them. We obſerve, that thoſe vapours which are in the Clouds, when the Air grows light, begin to fall, no doubt in the form of vapours; but afterwards ſuffering a conſiderable reſiſtance from the Air, they are condenſed into drops of Rain. If then the reſiſtance the vapours meet with for ſo ſmall a way, be ſufficient to condenſe them, is it not naturally impoſſible that they ſhould travel ſome thouſands of Miles and not be condenſed till they arive at the Poles?

Our Author proceeds in the next place to conſider the ſeventh Chapter of the Examination,

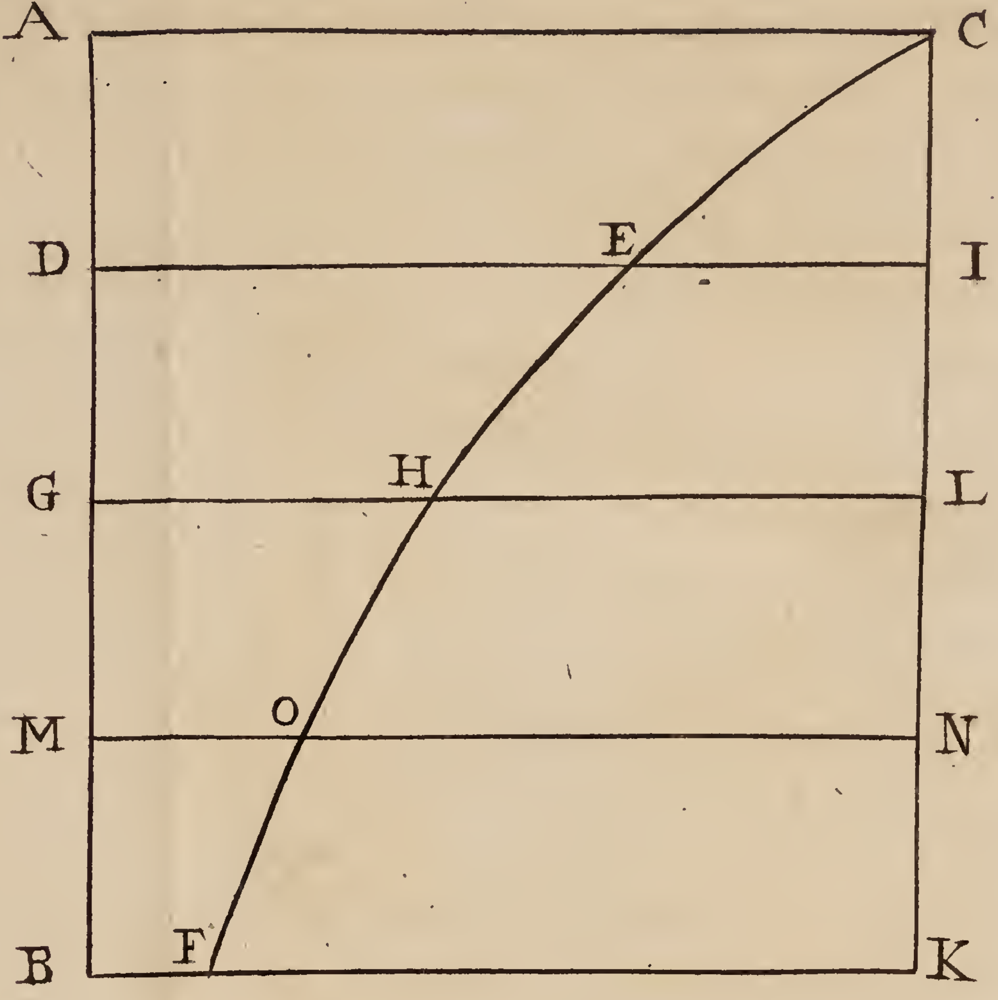
nation, and anſwer the arguments that are brought againſt the *Theoriſt's* way of making a Deluge. It is ſuppos'd in the Theory, that after ſome ages the heat of the Sun muſt have peirced thro' the Cruſt of the Earth, and reached the Abyſs, where it muſt have rarify'd the waters there, and rais'd an immenſe quantity of them into vapours, theſe endeavouring to expand themſelves, and the Pores of the Earth not being ſufficient to let them paſs thro', would preſs upon the Cruſt and break it into pieces, ſo that its fall upon the Abyſs, would produce an univerſal Deluge. Againſt this I objected, that it is impoſſible the heat of the Sun could reach far into the Earth, ſo as to perform any conſiderable effect; ſince by obſervation it was found, that in Caves and Vaults there was not any ſenſible alteration of heat in Summer and Winter; and therefore ſeeing that the heat of the Sun had ſo little effect in places of the Earth that were ſo near its ſurface, how could any one imagine that it would have any upon the Abyſs which was covered over with a thick Cruſt.

But becauſe this argument was propos'd in general terms, I endeavour'd to bring it to Calculation, in order to which I aſſumed one poſtulatum, *viz.* That fewer Rays of heat paſſed to the Abyſs thro' the Cruſt, than if it had been compos'd of ſeveral ſurfaces at ſome conſiderable diſtance from one another (ſuppoſe 10, 20, or 30, feet) every one of which reflected half the Rays which fell upon them, and tranſmitted the other half. This I thought was a poſtulatum which every body would have granted; and if we conſider how much of the Suns light and heat is diminiſhed by a thin Cloud of vapours, placed between it and us, and how much light is reflected by the common Air, when it paſſes thro' it, we cannot but own that the diminution of heat in paſſing thro' every 20 or 30 foot of a ſolid Cruſt, muſt be at leaſt the half of what falls upon it. Upon this ſuppoſition I ſhew'd, that if there were but one hundred of theſe ſurfaces, the number of Rays which fell upon the firſt, would be to the number of Rays which fell upon the laſt, as 2^{99} to 1 or as the *99th*, power of 2 to unity; from whence it followed, that if we took the diſtances as the Logarithms, the heat of the Sun at each of theſe diſtances, would be as the abſolute numbers belonging to theſe Logarithms; [*Fig.* 14. *Plate* VII.] Thus, if A B repreſented the thickneſs of the Cruſt, A C the number of Rays which fell upon the ſurface at A, D E the number of Rays which fell upon the ſurface at D; and if we draw thro' the points C and E the Logarithmick curve to the Aſymptote A B, the Applicate B F will repreſent the number of Rays which will fall upon the ſurface at B, which in our preſent caſe is vaſtly leſs than A C.

Inſtead

Plate VII

Fig. 14.



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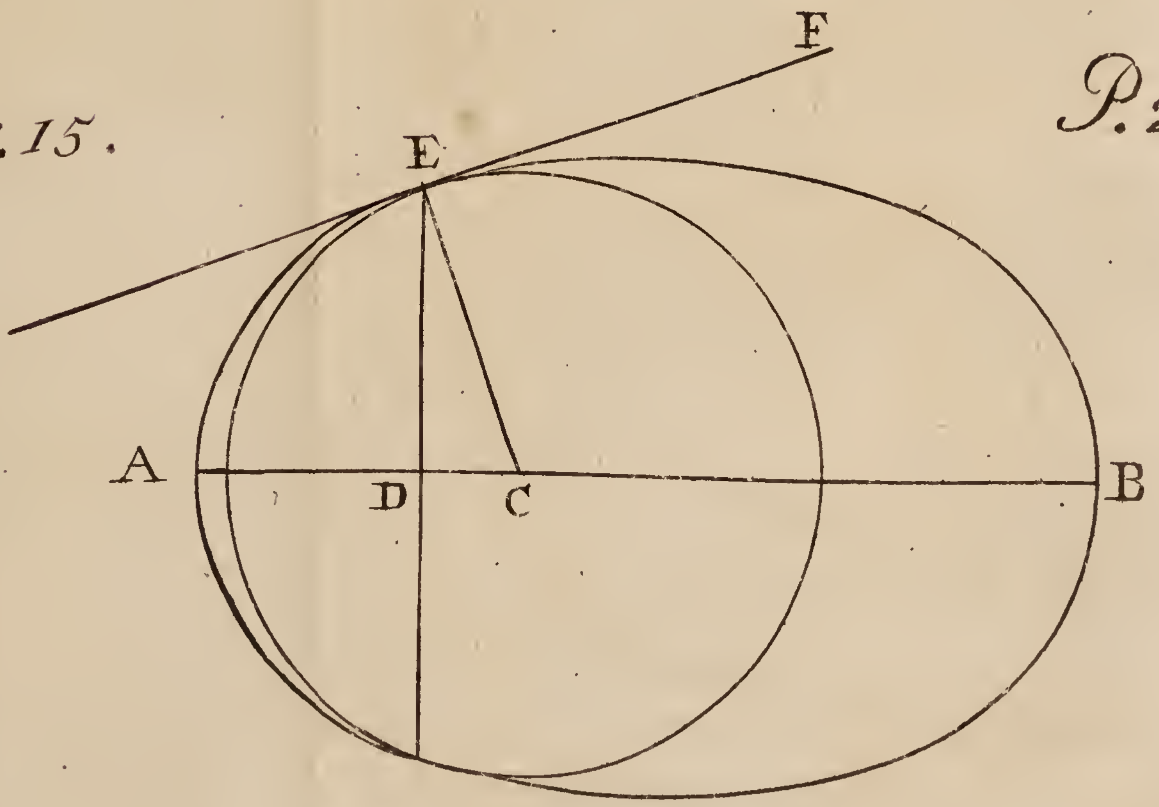
244.

Fig. 15.



P. 274.

Inſtead of denying any of the propoſitions of this argument, or ſhewing how the concluſion is faſly deduced from the premiſes, he anſwers that ſo we may divide an inch into an hundred or a thouſand ſurfaces, and prove from thence that no heat of the Sun could pierce thro' an inch of Earth. But is this a parallel caſe, is there not a vaſt diſproportion between an inch of Earth, and a vaſt denſe Cruſt of ſome Miles thickneſs? So that the poſtulatum which is true in the one caſe, cannot be ſuppos'd to be true in the other; if we ſhould ſuppoſe as many ſurfaces in one inch of Earth as we did in the whole Cruſt, then the diſtance between any two immediate ſurfaces of the Cruſt, would be to the diſtance between two immediate ſurfaces of the inch of Earth, as the thickneſs of the Cruſt to the thickneſs of an inch; and conſequently if A D repreſent the diſtance between the two firſt ſurfaces of the inch of Earth, A B the diſtance between the two firſt ſurfaces of the Cruſt, A C the Rays which fall on the firſt ſurface of both, E D the number of Rays which fall on the ſurface at D; the line F B which is the Applicate of the Logarithmick curve D E F, will repreſent the number of Rays which fall on the ſurface at B. For it is certain that the deeper any Rays paſs in any medium whether ſolid or fluid, they are ſtill the fewer, and both light and heat are more and more diminiſhed. Thus the Rays of the Sun paſſing thro' a far greater portion of the Air when it is near the *Horizon*, than when it is near the *Zenith*, is the cauſe that its light near the *Horizon* is much leſs than when he is in his Meridian Altitude; and the difference of his Illumination in both theſe places is ſo great, that we can eaſily look upon the Sun when he is Setting or Riſing, whereas we cannot turn our eyes to him without hurting them, when he is near our *Zenith*. Thus alſo it is obſerv'd by experience, that the deeper any Pool of water is, the fewer are the Rays which reach to the bottom of it; the ſame thing is alſo obſerv'd, if the medium is Glaſs or Chryſtal, or any other that lets either light or heat paſs thro' it.

Perhaps the *Defender* will ſay, that the Rays are diminiſhed in paſſing thro' a medium; but yet he does not ſee how they ſhould be diminiſhed in the proportion I have aſſign'd, *viz.* ſo that the Applicates to the Logarithmick curve are always as the quantity of Rays which paſs thro'. Well, that he may ſee that this is not a precarious aſſumption, I will give him my reaſon for it.

Let A B K C repreſent any medium thro' which the Rays paſs; let us ſuppoſe this medium to be divided into parts of equal thickneſs, A D, D G, G M, &c. let a repreſent the number of Rays which fall on the ſurface A C, and let $\frac{1}{m}a$ be thoſe which paſs thro' to the ſurface D I; becauſe the mediums A I, D L, are uniform, they will both tranſmit the light which falls upon them, in the ſame proportion, that is, becauſe both theſe mediums are by ſuppoſition of the ſame nature, equally denſe, and of the ſame thickneſs, and the Rays which fall upon both, have the ſame inclination, the quantity of Rays which fall upon the ſurface A C, will be to the quantity which paſſes thro' the medium A I and comes to the ſurface D I as that quantity which comes to D I is to the quantity which paſſes thro' D L, and comes to L C and by conſequence if a repreſent the number of Rays which fall upon A C, $\frac{1}{m}a$ the number which fall upon D I, $\frac{mm}{1}a$ will repreſent the number of thoſe that fall upon the ſurface G L. After the ſame manner $\frac{m^3}{1}a$ will be as the number of thoſe Rays which come to M N, and $\frac{m^4}{1}a$ will be the number of thoſe which fall upon F B, that is, If the diſtances A D, A G, A M, A B, are in an Arithmetical progreſſion, the Applicates A C, D E, G H, M O, F B, which repreſent the number of Rays that come to the points A, D, G, M, B, reſpectively, will be in a Geometrical progreſſion, which is the property of the Logarithmick curve.

Tho' this way of reaſoning by a Calculus, ſeems to be plain and obvious enough to thoſe who underſtand the common principles of Calculation, (which as I think ought to be unkown to none that pretend either to write or defend a Theory, as the *Theoriſt* himſelf owns) yet the *Defender* does whatever he can to find ſhifts and evaſions for ſuch arguments; and here he tells us, that we ought not to conſider ſurfaces but pores. Well, that he may ſee how ready I am to pleaſe and obey him, I have done this already in the 237*th* Page of this Treatiſe, where I have ſhew'd, that if the Sun ſhin'd upon any ſurface that is expoſed openly to it, its heat on that ſurface would be 202500 times greater than its heat upon the ſurface of the Abyſs, when it ſhin'd only thro' the Pores of the Cruſt. Which diſproportion is great enough to ſhew, that no great ſtore of vapours could be rarify'd in the Abyſs. But ſays he, thoſe that allow a Comet at its neareſt approach to the Sun, to be pierced thro' and thro', ſo as to become hotter than red hot iron, will not think it ſtrange that at our diſtance, it ſhould have ſome proportional effect upon the inward parts of the Earth. Let us illuſtrate his ſimilitude by another; Thoſe who allow that a ball of iron ten inches thick, when put in a good fire may be made red hot, and be peirced by the fire thro' and thro', will not think it ſtrange, that this ball of iron remov'd

10 feet from the fire, ſhould receive ſome proportionable heat even in its inward parts, as without doubt it would. But the queſtion is, if this effect is any way ſenſible, or if we ſhould ſuppoſe ſome water incloſed in the middle of this ball, whether the heat of the fire could raiſe it into vapour at ſuch a diſtance, ſo that the force thoſe vapours have to expand themſelves, would break or burſt the ball.

I thought that this Gentleman had known ſo much of the new Experimental Philoſophy, as not to be ignorant, that heat does not paſs into the interior parts of a ſolid of conſiderable thickneſs, till it has quite diſſolved the Exterior parts; and if the ſolid is combuſtible, (as wood) it conſumes the outward parts, before it has any ſenſible effect upon the Interior; but if its parts are compact, (as Metals or Stone) it looſens and diſſolves the frame and texture of the outward parts, and ſo makes its way to the inward.

But our Philoſopher thinks he has found out one remarkable *Phænomenon*, by which he can prove effectually, that the heat of the Sun peirces deep into the Cruſt, and that is in the caſe of the Earthquakes. He conſiders the cauſe of them, and their depths, and he ſays, that all agree that they ariſe from the rarefaction of Vapours and Exhalations; This rarefaction (ſays he) muſt be made by ſome heat, and no other is prov'd to us yet by this Author, than the heat of the Sun.

Why ſhould I be oblig'd to ſatisfy him in all his difficulties in Philoſophy? Did ever I ſet up to be a *Theoriſt*, and give an account of all the *Phænomena* of Nature? Well; but it ſeems he expects it from me, and tho' I am no ways oblig'd to it, yet out of abundance of good nature, I will give my opinion in this matter.

I think then that the rarefaction of Vapours within the Earth, may ariſe from another heat than that of the Sun. We know that there is an actual fire which always burns in ſeveral places of it, which ſometimes burſts out and makes an horrible eruption, as in all Vulcano's and Fiery Mountains; and why may not this fire be the cauſe of the rarefaction? This appears to be more probable, becauſe Earthquakes are moſt common in thoſe places where theſe Vulcanos are, as in the Kingdom of *Naples* and *Sicily*.

But ſuppoſing there were no actual fire under ground, yet I am of the opinion, that heat may ariſe from other cauſes than that of the Sun. It is obſerv'd, that from a due mixture of ſome particles of matter with thoſe of another ſort, there will ariſe a very conſiderable heat: Some places underground are obſerv'd to be exceeding hot, as ſome Mines, (where there is a mixture of Sulphureous, Nitrous, and Mineral principles) the heat is ſo conſiderable, that a Man cannot eaſily endure it, even in the extremity of Winter. There are other places ſo warm, that the waters that run thro' them will ſcald a Mans hand. And may we not ſuppoſe, that there are ſome Cavities deeper underground, where the Earth is of the ſame frame and texture of parts? Now if ſome Sulphureous and Nitrous Exhalations, ſhould be gathered together within any of theſe Cavities, and by motion, or any other accident, they ſhould happen to be kindled, it is plain they will expand themſelves, rarify the Air, and make that Concuſſion of the ground we uſually obſerve in Earthquakes.

Now it is plain, that theſe Exhalations may be kindled without the heat of the Sun, from obſervations that are daily to be made in our Atmoſphere; where the Sulphureous Exhalations that are the cauſe of Thunder and Lightning are kindled in the Air, when the action of the Sun is not ſtrong. This is alſo obſerv'd of Meteors, (which we commonly call falling Stars) whoſe matter is kindled in the night-time, when the immediate heat of the Sun can have as little effect as it has within the bowels of the Earth: and I hope this will be ſufficient to ſatisfy him, that Earthquakes may ariſe from other cauſes than the heat of the Sun.

Tho' the arguments I have already given, clearly prove, that there was no rarefaction of the vapours, cauſed by the heat of the Sun within the Abyſs, yet I ſhew'd, that granting the Suns heat had reach't the Abyſs, even then an Univerſal Deluge could not follow from thence; becauſe I demonſtrated by a Calculation, that if the Suns heat drew vapours from the Abyſs ſufficient to furniſh the Rivers on the Earth, it muſt have exhauſted this great treaſure long before the time of the Deluge. This manner of Examining the *Defender* calls contention, and going from one extream to another; tho' for my part, I think there cannot be fairer dealing, than firſt to prove that his Principles and Hypotheſes are falſe and diſagreeable to Nature; and then (ſuppoſing them true) to ſhew, that his reaſonings upon 'em are falſe and inconcluſive, and the cauſes he aſſigns are no ways proportionable to the effects he would account for.

However, our Author aſſures us, that there are a great many uncertainties in the computation. He knows I did not pretend to give an exact eſtimation of the Water that the Rivers ſent into the Sea. I can ſuppoſe that I have not come within the truth by one, two, or three Cubical Miles of Water, (which is as much as I need to allow) nay, I will grant him, that I have erred a twentieth part, or even one half if he pleaſes, and yet the argument will be ſtrong enough. For according to the computation, the Abyſs ought to have been exhauſted in the ſpace of 460 Years; now from the Creation to the time of the Deluge, there were 1600 Years. By which it is evident, that which ever of theſe Hypotheſes he takes, the Abyſs muſt have been empty long before the time of the Deluge.

But he thinks I go in this Calculation on principles that are not allow'd by the *Theoriſt*, becauſe I ſuppoſe the Waters of the preſent Sea equal to the Waters of the great Abyſs; whereas (ſays he) there was near twice as much Water in the great deep, as is now in the Ocean, ſeeing the Abyſs was extended under the whole Earth, and the Sea reaches but to the half of it. I always preſum'd that it was the *Theoriſt*'s Hypotheſis, that the Cruſt fell down upon the Abyſs and drove the Waters from their place, ſo that the greateſt part of the Waters in the Abyſs (after they had overflowed the Earth) came and ſettled at laſt in the Sea. There might indeed have been ſome Water left in the Hollows and Cavities of the Earth, but 'twould be inconſiderable in reſpect of the whole; and the *Theoriſt* himſelf aſſerts, that if the Earth ſhould diſgorge all the Waters in its bowels, it would not amount to above half an Ocean; and in the *Latin* Edition he thinks, that it is altogether incredible, that the Water within the Earth ſhould be as great as what is in the Sea and Rivers. So that this Gentleman, who aſſerts that there was almoſt twice as much Water in the Abyſs as there is now in the Ocean, ſeems never to have read the Theory, or to have underſtood the *Theoriſt*'s Hypotheſis which he endeavours to defend.

But what if there were twice as much Water in the Abyſs as there is now in the Ocean; yet even in that caſe the whole muſt have been exhauſted long before the Deluge, ſince one Ocean could have been drawn up in the ſpace of 460 Years: Nay, if we ſuppoſe that there were but juſt ſo many Rivers in the Primitive Earth as there are now in ours; (whereas in proportion to the dry Land there ought to have been twice as many) yet in the ſpace of 1600 Years, there is time enough to have the whole Abyſs exhauſted, as is evident by the Calculation.

The *Defender* alledges, that the Rivers were not ſupply'd by the vapours, only from the Abyſs, but alſo from the Earth and Waters upon it. This evaſion was foreſeen, and obviated by me in the 130*th* Page of the Examination; where I prov'd that there muſt be at leaſt the ſame quantity of vapour exhal'd from the Abyſs as was before, becauſe the ſame cauſe ſtill continuing to act, would ſtill produce the ſame effect, and the Abyſs having at firſt furniſhed the Rivers with a ſufficient quantity of Water, would ſtill continue to furniſh 'em in the ſame quantity, nay rather in a much greater; ſince (according to the Theory) the heat of the Sun was ſtronger and ſtronger every day upon the Abyſs, and the vapours exhal'd were ſo many at laſt, that not being all of them able to crowd thro' the Pores, they broke the thick Cruſt of the Earth with their violent effect to expand themſelves and fly upwards. Thus we ſee all the ſhifts and evaſions which this Author makes, are not of the leaſt weight againſt my computation.

But ſuppoſing that all the Water in the preſent Ocean was then in the Abyſs, yet I prov'd, that from the fall of the Cruſt, there could ariſe no Univerſal Deluge, becauſe the *Theoriſt* himſelf prov'd, that there muſt be at leaſt eight Oceans of Water requir'd to cover the Earth. The *Defender* confeſſes, that the Water in the Abyſs was not ſufficient to make a Deluge in the nature of a ſtanding Pool, over-topping and ſtanding calm over the heads of the higheſt Mountains; (as it is uſually conceiv'd) but the Deluge that roſe from the fall of the Cruſt was rather like a ruſhing Sea, overflowing and ſweeping them with its Raging Waves and Impetuous Fluctuations. I beg the *Theoriſt*'s pardon for miſtaking him: I thought that he deſign'd to explain *Noah's* Deluge, and not one of his own imagination. Now I can eaſily prove, that ſuch a Deluge as this Gentleman conceives, is no ways like that which happen'd in the days of *Noah*. For tho' the *Theoriſt* computed but eight Oceans of Water that were ſufficient to cover the whole Earth above the tops of the higheſt Mountains, yet I determined the quantity more nicely in my Remarks on Mr. *Whiſton's Theory*, where I prov'd, that there muſt be at leaſt three and twenty Oceans of Water that were neceſſary for ſuch an effect. From which it is evident, that the Water in the Abyſs could but cover one part of twenty three at a time, and the other twenty two parts muſt remain dry; and that after the Water had overflowed this part, it muſt have proceeded to the next, and ſo ſucceſſively, till at laſt it had overflow'd the whole Earth. This is the way that our Author muſt conceive the Deluge.

Let us ſee now what account the Scriptures give us of *Noah*'s Deluge. *Geneſ. Chap.* 7. *v.* 2. it is ſaid, *That the fountains of the great deep were broken up, and the windows of heaven were opened, and the rain was upon the Earth forty days and forty nights.* And again, verſ. 17. *And the flood was forty days upon the Earth, and the waters encreaſed and bare up the Ark, and it was lift up above the Earth.* verſ. 18. *And the waters prevailed, and were encreaſed greatly upon the Earth, and the Ark went upon the face of the waters.* verſ. 19. *And the waters prevailed exceedingly upon the Earth, and all the high hills that were under the whole heavens were covered.* verſ. 20. *Fifteen cubits upwards did the waters prevail, and the mountains were covered.*

covered. verſ. 24. *And the waters prevailed upon the Earth an hundred and fifty days.* Chap. 8. verſ. 1. *And God made a wind to paſs over the Earth, and the waters aſſwaged.* verſ. 2. *The fountains alſo of the deep and the windows of heaven were ſtopped, and the rain from heaven was reſtrained.* verſ. 3. *And the waters returned from off the Earth continually, and after the end of the hundred and fifty days, the waters were abated.* verſ. 5. *And the waters decreaſed continually until the tenth month. In the tenth month, on the fifth day of the month were the tops of the mountains ſeen.*

We may obſerve from this, that the Scriptures inform us, that the whole Earth was under a Deluge at the ſame time, that the waters encreaſed and prevailed gradually every where for the ſpace of 150 days, that all the high hills under the whole heavens were covered, that all theſe Mountains lay under Water for ſeveral months, that the Ark ſwam and was carry'd up above the Mountains, and when the Waters began to abate, it reſted at laſt upon one of them; that it was the eighth month from the beginning of the Deluge when the tops of the Mountains firſt began to appear, till which time they lay all of them hid and covered with Water. Now in the *Theoriſt*'s imaginary Deluge, it is plain, (as I have already obſerv'd) that there was but a twenty third part of the Earth covered with Water at the ſame time;

it is alſo evident, that the Waters could not encreaſe gradually in any one place for the ſpace of 150 days, ſince the whole Earth was to be cover'd over with waters in that time. His ſingle Ocean of Water could not ſtay but the three and twentieth part of that time in one place, and therefore it muſt have gone off from that place, and left it dry long before the end of thoſe days.

Nor is this Idea of a Deluge leſs conſiſtent with Reaſon and Philoſophy, than it is with Scripture. Is it poſſible to conceive moving, wandring Mountain of Water? For Water naturally ſettles its ſelf into a ſurface concentrical to the Earth; and by whatever force, or however it ſhould be rais'd into an heap, it will immediately ſpread it ſelf uniformly upon the ſurface of the Earth, and deſcend by whatever ways it can. If therefore we ſhould ſuppoſe all the waters in the Abyſs drawn or forced up to cover the hills of any one place, it will immediately deſcend and form it ſelf into a ſurface parallel to the *Horizon*, and ſo ſpread its ſelf equally every where upon the Valleys of the Earth, leaving the Mountains quite uncover'd. The *Theoriſt* himſelf acknowledges, that a Mountain of Water is an impoſſible thing; and indeed, this notion of a Deluge ſeems to be ſo extravagant, that I can ſcarce think that any body will be ſo credulous as to believe it; and yet it is impoſſible that it can be any other ways, if we ſuppoſe all the Mountains of the Earth to have been cover'd with an Ocean of Water, of no greater dimenſions than that aſſign'd in the Theory, which cannot cover more than the three and twentieth part of the Earths ſurface.

The *Defender* in vain alledges, that we are to conceive this Ocean as a mighty ruſhing Sea, overflowing and ſweeping with its raging Waves and Impetuous Fluctuations, all the Mountains; for this will not at all take away the abſurdity, becauſe motion can never multiply any body, nor make it to be at more places than one at a time. Water can only by motion be in many places ſucceſſively, which will give us the Idea of ſuch a moving heap or Mountain of waters, as we have juſt now prov'd impoſſible. Nor is this notion of a Deluge agreeable to the principles of the Theory. For let us ſuppoſe the Cruſt to have been broken by the force of vapours endeavouring to expand themſelves, it muſt immediately fall down and drive the Water of the Abyſs out of its place, ſome one way, and ſome another; this Water will aſcend with a very conſiderable force, let us ſuppoſe as far as five Miles perpendicular heighth, after which it will deſcend again and fall to the ground; and all this will be by computation in much leſs time than one day. Theſe waters having acquired a great force by their fall, will deſcend very ſwiftly into the Vallies and Cavities of the Earth, and leave both Mountains and Upper-grounds quite uncovered. And as the Waters that were raiſed by the fall of the Cruſt, could cover no more than a twenty third part of the Earths ſurface, ſo it is evident it could remain but a very ſhort time upon the tops of thoſe Mountains it overflow'd; whereas in *Noah's* Deluge, all the Mountains of the Earth lay under water for the ſpace of 150 days. Thus I have prov'd, that the Deluge the *Defender* endeavour'd to explain, is neither conſiſtent with the holy Scriptures, true Reaſon and Philoſophy, nor the Principles of the Theory, from whence he pretends to deduce it.

Of the Figure of the Earth.

THO' what the *Theoriſt* has ſaid in relation to the Figure of the Earth, be one of his groſſeſt and moſt palpable errors, and tho' there is a poſitive demonſtration that it is of a Figure directly contrary to that he aſſigns, yet his *Defender* thinks himſelf oblig'd to maintain it, and therefore ſpends more time and paper about it, than upon any other point.

He is not contented with what has been ſaid by ſeveral Mathematicians and Philoſophers of the preſent Age upon this Subject; tho' one would think that they knew the methods to determine the Figure of the Earth much better than either the *Theoriſt* or himſelf. He is afraid that they will give it againſt him, and therefore he appeals from them to ſome farther Obſervations, that He and the *Theoriſt* point out and direct us to make. As to obſerve for inſtance, whether the extent of a degree be the ſame in different Latitudes, or whether the ſhadow of the Earth in a total Eclipſe of the Moon be truly round; as alſo to obſerve if towards the Poles, the return of the Sun to their Horizon be according to the rules of a Sphærical Surface of the Earth. Theſe are the Obſervations the *Theoriſt* would have made to determine the controverſy. Which I will now conſider, leaving the *Defenders* Obſervations to be examined in a proper place.

I noted in the Examination, that I did not think any Obſervations that could be made upon different meaſures of a Degree in different Latitudes, could be ſo nice and exact, as would be neceſſary to determine the point in controverſy. For ſuppoſing that the greateſt Diameter of the Earth were to its leaſt as 101 to 100, by which one Semidiameter would be very near 40 Miles greater than the other; (a difference which his friend who was ſo kind as to write him a Letter, thinks to be much too great) and then the greateſt Degree upon the Meridian, would be to the leaſt very near in the ſame proportion; that is, it would be 1 part of 100 greater than the other; but this difference is ſo very ſmall, that I believe no Obſervations in order to this diſcovery, are nice enough to be rely'd upon. For where the length of a Degree in Miles is determin'd either by the reſolution of many right-lined or Spherical Triangles, it is ſcarcely probable, that the errors in Obſervations and Meaſuring, will amount to leſs than $\frac{2}{3}$ of a Mile.

Tho' therefore we can ſcarce hope of ever attaining to a knowledge of the Earths Figure by meaſuring of it, yet to ſatisfy the *Theoriſt* in this matter, I took notice of one Dr. *Eiſenſchmidt*, who compares the magnitude of Degrees obſerv'd in different Latitudes, and finds that they are greater at the Equator than at the Poles, and that they gradually decreaſed from the Equator towards either of the Poles; from which he infers, that the Earth is of ſuch a Figure as the *Theoriſt* has aſſign'd to it, whereas I following the *Theoriſts* principles, demonſtrated that the Earth muſt have another Figure, and that the Diameter of the Equator muſt be greater than its Axis.

But our *Defender* ſays, that my demonſtration proceeds upon a ſuppoſition, that the *Vertical Lines* or the *Lines of Gravity* (I ſuppoſe he means the Lines of direction of heavy Bodies) are to be drawn directly to the Center. Does not the *Theoriſt* admit of the ſame ſuppoſition? Does not he make the Water deſcend from the Poles to the Equator, that it may be ſo much nigher to the Center? Since therefore according to the *Theoriſt*, the Lines of direction of heavy Bodies are towards the Center of the Earth, and (if we proceed upon that Hypotheſis) where the Degrees are greateſt, there the Earth muſt have its Diameter greateſt, it will evidently follow from *Eiſenſchmidt*'s Obſervations, that the Earth muſt not be an oblong Spheroid but a broad one, and have its Axis ſhorter than the Diameter of its Equator.

Our *Defender* tells us, that Dr. *Eiſenſchmidt* ſuppoſes the Vertical Lines or Lines of Gravity, to be drawn at right Angels to the Tangent of each reſpective Horizon. What Dr. *Eiſenſchmidt* does really ſuppoſe I know not, but I am ſure he cannot ſuppoſe a thing more abſurd than what our Author makes him ſuppoſe in this place. For that the Line of direction of heavy Bodies is at right Angles with the Tangent of the Horizon, is to me ſuch an incomprehenſible ſuppoſition, that I ſhall excuſe my ſelf from conſidering of it, till the *Defender* (who I ſuppoſe would have us think he underſtands it) is at leiſure to explain it.

I have not ſeen Dr. *Eiſenſchmidt*'s own Book, to know upon what principles he proceeds: It is ſaid in the *Acta Eruditorum*, that he embraced the *Theoriſt*'s opinion about the Figure of the Earth; and I believ'd that therefore he would follow his and the common opinion, that all heavy Bodies tend toward the Center of the Earth; becauſe it ſeems moſt reaſonable, that the direction of heavy Bodies ſhould be towards the Earth's Center of Gravity, which we may ſuppoſe to be the ſame with its Center of Magnitude. Nor can we ſuppoſe this direction to be any ways chang'd, but upon the account of the centrifugal force, that all Bodies in the Earth have acquir'd by being turn'd round the Earths Axis. Now if he had taken the Centrifugal force into his conſideration, he muſt have concluded (as I have done) that the Earth had the Diameter of its Equator greater than its Axis, which is ſtill contrary to the concluſion he made. So we ſee, that whether this Author ſuppoſes the direction of heavy Bodies to be towards the Center of the Earth, that then by Obſervations he muſt have concluded, the Earth to have been of a broad Spheroidical Figure; or whether he ſuppoſes the Lines of direction of heavy Bodies to be chang'd by a Centrifugal force, he ought to have drawn the ſame conſequence from thence, tho' not indeed from his Obſervations of a degree meaſured in ſeveral Latitudes.

The *Defender* not daring to truſt much to his own skill in this matter, has obtain'd a Letter from a Gentleman of his acquaintance concerning it. But all that Gentleman's reaſons depend on a ſuppoſition which the *Theoriſt* cannot allow, *viz.* That the Tangents of the Ellipſe are in the Horizontal Plane; whereas it is evident, that according to the *Theoriſt*'s Hypotheſis, theſe Tangents can never repreſent the Horizons, for he makes the Water to run from them down to the Equator: now it is certain that Water will not run if it be placed upon an Horizontal Plane; and if we are to make Water run any way, we muſt always make its Channel inclined to the Horizon.

This Gentleman indeed reaſons truly, provided the Lines of direction of heavy Bodies were always perpendicular to a Plane, touching the Spheroid in the point where the Body falls; but as I have already obſerv'd, this ſuppoſition is not to be admitted by the *Theoriſt*, and we can no more ſuppoſe a Plane touching a Spheroid to be the Horizon of the point where it touches, than we can ſuppoſe a Man who ſtands upon the ſide of a Hill, to have that plane for his Horizon which touches the ſide of the Hill in the point of his ſtation.

Thus, I think I have plainly prov'd, that there is no certain way to determine the Figure of the Earth from the obſervations of a degree taken in ſeveral Latitudes; yet I have ſhewn, that if either the *Theoriſt* or his *Defender* will depend upon thoſe obſervations which are already made; we muſt conclude from their own principles by evident demonſtration, that the Earth is of a very different Figure from what they aſſign it.

The next way the *Theoriſt* would take to determine the Earth's Figure, is by its ſhadow upon the Moon: But it is eaſy to prove this way as uncertain as the other. For let us ſuppoſe (as we have done already) that the greateſt Diameter of the Earth is to its leaſt, as 101 to 100, (which is a much greater proportion than what is allowed either by Mr. *Newton* or Monſ. *Hugens*) becauſe by obſervation, the Diameter of the Earth's ſhadow, is three times the Diameter of the Moon, and the Moon appears under an Angle of 30 Minutes, therefore the Diameter of the Earth's ſhadow ſeen at that diſtance, will appear under an Angle of 90 minutes or a degree and half; and therefore if we ſuppoſe the Diameter of the ſhadow to be divided into an 100 equal parts, (the whole appearing under an Angle of 90 minutes) every one of theſe parts will be ſeen under an Angle of $\frac{90}{100}$ or $\frac{9}{10}$ parts of a minute; that is, in our preſent caſe, one Diameter of the ſhadow will appear under a greater Angle than the other, by $\frac{9}{10}$ parts of a minute. Now by experience we find, that any object that appears under an Angle that is leſs than a minute, is ſeen as if it were a point. It is therefore plain, that if there were a Lucid Body whoſe Disk is large enough to receive the whole ſhadow of the Earth, that we could obſerve no ſenſible difference between the length of its Diameters; but if this Lucid Body had its Disk but juſt big enough to receive a $\frac{1}{3}$ part of the Earth's ſhadow, (as it really is in the Moon) it is moſt evident that we could not determine the Figure of the ſhadow near ſo nicely, as in the former caſe. We ſee then that by the Earth's ſhadow upon the Moon, its Figure is not to be determined with any tolerable exactneſs.

The third obſervation the *Theoriſt* would have us make, is about the return of the Sun to the Polar parts of the Earth, whether that be according to the rules of a Spherical ſurface. But this method is as little to be rely'd upon as any of the reſt. The various refractions of the cold and thick Atmoſphere, make all obſervations that are made there, very doubtful and uncertain: Beſides, the Latitudes of thoſe places that are near the Poles, are not exactly determin'd, ſo that there is no truſting to obſervations that have been already made, and I believe no body will go now to theſe places and Winter in them,on purpoſe to make new and more exact obſervations to determine this controverſy.

The *Defender*, having thus pointed out the *Theoriſt's* own obſervations, comes now to conſider the arguments that are brought by thoſe, who ſay that the Earth is of a broad Spheroidical Figure. He tells us, that the learned Mr. *Hugens* thinks it may be prov'd by experiments made about the different Vibrations of a Pendulum in different Latitudes; and brings an inſtance of an experiment made at *Cayenne* in *America*, where it was obſerv'd, that a Pendulum Vibrating in a ſecond is ſhorter than one at *Paris* that performs its Vibrations in that time; from which he ſays, he concludes that Gravitation is leſs under and near the Equator than towards the Poles, and from thence, that the Figure of the Earth is protuberant and riſes in the middle, its ſhorteſt Diameter being betwixt Pole and Pole.

We ſee here that our Author aſcribes the obſervation about the Figure of the Earth, drawn from an experiment of Pendulums to Monſ. *Hugens*, whereas it was Mr. *Newton* who firſt made the diſcovery, from whom Mr. *Hugens* had it; and this Writer in juſtice ought to have aſcribed it to its true and genuine Author. But this is not the firſt time that the honour of ſeveral noble Inventions, which the World owes to that excellent Geometer and Philoſopher, has been given to others.

The *Defender* tells us, that there are ſeveral things to be conſidered before we come to the concluſion; firſt the matter of fact, concerning the inequality of Vibrations of equal Pendulums in different Latitudes; and then the inferences made from that inequality. As to the matter of fact, he tells us, that it was Mr. *Richer* who made the experiment, whoſe Perſon or Character he does not know, or whether his relation be extant in Print. 'Tis ſtrange, that the *Defender* thinks that no body is to be truſted in a Philoſophical experiment; but thoſe whoſe Perſons and Characters he knows,

knows. Has he ſuch an univerſal acquaintance, as to have an exact knowledge of all thoſe who are fit to make Obſervations and Experiments in Natural Philoſophy? Certainly he muſt think, that the Gentlemen of the Royal Academy are better Judges of that than he is. Monſ. *Richer* was choſen by them, and ſent at the command and charges of the *French* King, to make Obſervations in the South parts of the World; and doubtleſs, when theſe Obſervations were to be made by order, and at the expences of their King and Patron, they would never chooſe any but one whom they knew to be well qualify'd for ſuch an undertaking. And Monſ. *Richer* himſelf has juſtify'd the judgement of thoſe that choſe him, by his excellent Obſervations, both Aſtrononiical and Phyſical, that have been ſo well received by the Learned. Among the reſt, he gives us an account of this Obſervation about the Pendulum very exactly; He tells us, that during the ten months he ſtay'd at *Cayenne*, there ſcarce paſſed a week in which he did not make the Obſervation, and found it always the ſame.

Monſ. *Vaun*, Monſ. *Hayes*, and Monſ. *Du Gloſs*, were alſo choſen by the ſame Academy, and ſent to the Iſland *Goree* in *Africk*. They had it particularly in their inſtructions, to make Obſervations about the Pendulums; which they did, and confirm'd the Experiments made by Monſ. *Richer*. We may ſee a particular account of all their Obſervations in the *Reccuill des Obſervations faites en divers Voyages per l'ordre de ſa Majeſté*, in Fol. printed at the Royal Preſs in *Paris*.

To all this we may add, that the ingenious Mr. *Halley* when he went to St. *Helena*, (having firſt fitted the length of his Pendulums for Vibrating ſeconds at *London*) found afterwards that length at St. *Helena* to be too great; and therefore he was forced to ſhorten it, that it might Vibrate ſeconds there; tho' he did not then obſerve the exact difference between them. Theſe repeated Experiments I hope will put the matter of fact paſt all doubt.

But (ſays our Author) even Monſ. *Hugens* ſpeaks dubiouſly of the Experiment. This I deny; for Monſ. *Hugens* never in the leaſt doubted of the Experiment, *viz.* That a Pendulum Vibrating ſeconds at the Equator, muſt be ſhorter than a Pendulum performing its Vibrations in the ſame time at *Paris*; for he has given evident demonſtration that it muſt be ſo. Monſ. *Hugens* only doubted whether Monſ. *Richer* had obſerved exactly the difference of their lengths; being fully aſſured in the mean time that there was a difference, as will be plain to any body that will be at the pains to read his Book. The reaſon why he doubted if Monſ. *Richer* had given us the exact difference was, becauſe he found that the difference obſerv'd by him, did not anſwer the numbers he brought from his own Calculation, which proceed upon a ſuppoſition that

Gravity at all diſtances from the Center is the ſame.

But it ſeems the *Defender* does not ſee the conſequence which is drawn from thence, *viz.* That Gravity muſt be leſs at the Equator than at the Poles, and therefore wiſhes that it were prov'd by other Experiments. It is ſtrange and ſurpriſing, that this Author ſhould know exactly how the Earth was made, by what Principles and Laws of Mechaniſm the World was framed, how the Deluge overſpread the World, and what way the Mountains aroſe, and yet ſhould be ignorant of ſo plain and eaſy a piece of Mechaniſm as this, which has not the hundredth part of the difficulty or intricacy of thoſe which he pretends to know. Well, to convince him I will here repeat the demonſtration ſomewhat plainer than I did in the Examination.

Let us ſuppoſe two bodies moving in two equal Cycloids; it is demonſtrated by Mr. *Hugens* that the time of the deſcent thro' theſe Cycloids, is to the time of the deſcent thro' the Axis of the Cycloids always in a given proportion, *viz.* as the Semiperiphery of a Circle is to its Diameter; and therefore if the time of the deſcent or vibration in theſe two equal *Cycloids*, ſhould be unequal, the time of the deſcent thro' their *Axes* will be alſo unequal. Now the *Axes* of the Cycloids being equal, and the time in which the Bodies move thro' them, unequal, it is evident that the two forces which move theſe two Bodies muſt alſo be unequal; that is, the accelerating force of Gravity in the one, will be greater than the accelerating force in the other; or which is the ſame thing, (ſuppoſing the Bodies equal) the *Conatus* that the one has to go downwards, will be ſtronger than the *Conatus* that the other has to go downwards, that is, the Gravity of the one will be greater than the Gravity in the other.

Now this is the very caſe in hand; for we find by the Obſervations of Pendulums, that a Body Vibrating in a Cycloid here, will perform its Vibrations in ſhorter time, than when it Vibrates in the ſame Cycloid at the Equator; and therefore it is a demonſtration that the Gravity at the Equator is not ſo great as it is here. Which if the *Defender* had well underſtood, he needed not to have troubled himſelf about the making of other Experiments, ſince there can be none that are more nice than this. For tho' the difference of time for one ſingle Vibration be very inſenſible, yet this difference being often repeated, will come at laſt to be very ſenſible, and by obſerving it for a longer time, we may come to as great exactneſs as we pleaſe.

From this we may conclude, that there can be no experiments made which will more nicely determine the different Gravities at the Equator and here, than what is to be done by obſervations from Pendulums; and that no body will ſpeak againſt ſuch Experimens, but they who do not underſtand them. But however we will now conſider the Experiments the *Defender* would have made to examine the different Gravities here and at the Equator.

He tells us, he would not have it made by a Balance or Scales, but by ſuch powers as do not immediately depend upon Gravity, as Springs or other Engines, Rarefactions, or whatſoever has the force to raiſe, ſuſtain, or remove, ponderous Bodies. But how does this Author know, but theſe Springs and Engines may change their force alſo at the Equator, and ſo be able to raiſe no greater weight than they will do here. Has not the weather a very great effect upon the Elaſticity of all ſorts of Springs, which it alters according to the dryneſs or dampneſs of the Air? And can we be ſure that the ſame Spring in ſo different Climates and ſeaſons, will preſerve the ſame Elaſticity? But granting that Springs would not alter their Elaſticity in different Climates and ſeaſons, yet the difference between the Gravity here, and that which is at the Equator is ſo ſmall, (the one being to the other as *690* to *689*) that the difference of their effects would be ſcarce ſenſible. For let us ſuppoſe that a weight here extended a Spring to the length of an inch, the ſame weight would not draw it out ſo far at the Equator, by $\frac{1}{690}$ of an inch, which quantity is ſo ſmall, that we ſhould need good Microſcopes to perceive it.

The next Experiment the *Defender* would try, is that of the Barometer; for he thinks the *Mercury* ſhould ſink much lower there than with us, or indeed, to nothing if the height be comparatively ſo great as is ſuppoſed. It is hard to conceive, why the *Mercury* ſhould ſink lower at the Equator than it does here. I cannot ſuppoſe he concludes ſo, becauſe it is lighter there than here; for upon that account it ought to riſe higher, neither can I ſuppoſe that he thinks it ought to ſink, becauſe the Air is not ſo high there as here; for the Air turns round the Earths Axis as well as other Bodies, and therefore it muſt have a Centrifugal force as the reſt have; and where this Centrifugal force is greateſt (which is under the Equator) it will riſe higheſt from the ſurface of the Earth. Since then we can ſee no way by which he can prove this paradox, we muſt leave it, and deſire him to make it out in his next Book.

There are ſome other Experiments, that the *Defender* would try to know the exact Figure of the Earth; as for inſtance, He ſays, " the height of the Equator ſhould " make a different Horizon (as to the Hea- " vens, or the Earth and Sea) Eaſt and Weſt, " from North and South, the Figure of the " Earth being a Sphere one way, and a Sphe- " roid the other, the Sea alſo muſt be ſeven-

“ teen miles deeper at the Equator than at “ the Poles. Then in reference to Rivers, “ the motion of thoſe that riſe near the Equator muſt be ſwift and rapid, but very “ ſlow muſt the motion be of thoſe that aſcend to it, if at all they can be ſuppos'd to “ climb ſo great a Hill.

“ The great River of the *Amazons* riſes “ five degrees from the Equator, yet runs up “ to the Equator with a vaſt load of Waters. “ *Rio de Nigro* has a longer courſe againſt “ the bent of the Earth, and croſſing the “ Equator falls into the Southern Sea. The “ *Nile* in *Africk* croſſes the Line, and has a “ long courſe on this ſide of it. Rivers do “ not riſe higher by a natural courſe than “ the Fountains head, and Hydrographers “ do not aſſign above two foot in a mile for “ the deſcent of Rivers: but upon this Hypotheſis, there will be fourteen or fifteen “ foot for every mile in Rivers deſcending “ from the Equator; which is a precipitation “ rather than a Navigable Stream. Suppoſe “ (ſays he) a Canal cut from the Equator to “ the Poles; it would be a paradox to ſay, “ that water would not flow in this Canal “ having fourteen or fifteen foot deſcent for “ every mile; but it would be a greater Paradox to ſuppoſe, that Rivers would riſe to “ the Equator, and with the ſame celerity “ as we ſee they do upon an aſcent of ſo “ many feet.

Theſe are the *Defender*'s thoughts on this ſubject: it is ſcarce imaginable how any one ſhould be ſo forward in defending the Theory, that appears ſo entirely unacquainted with Natural Philoſophy, as this Author does. However, if it be not too late for him to learn, I will do what I can to inform him, and conſider what he has ſaid.

His firſt thought, that there ſhould be a different Horizon, as to the Heavens, the Earth and the Sea, Eaſt and Weſt, from North and South, the Figure of the Earth being a Sphere one way and a Spheroid another, is ſuch unintelligible language as would puzzle a Mathematician to imagine, how it were poſſible for a Man to put ſuch words together, with a deſign to mean any thing. But however, if I may humbly gueſs at what this incomprehenſible Gentleman intends; I ſuppoſe he would ſay that the Section of the Earth is a Circle one way, and an Ellipſis the other.

Now I can eaſily demonſtrate, that if the Earth were a Spheroid, any point of it would have no other Horizon than what ſome would have a Sphere, whoſe Axis is in the Axis of the Ellipſe; thus, [*Fig.* 15. *Plate* VII.] Let A E B be an Ellipſis, E F a Tangent to it in the point E, to which erect the perpendicular E C meeting with the Axis in C at the Center C, and the diſtance C E, deſcribe a Circle; it is plain, that this Circle will be touched by the ſtreight line E F in the point E, and if both the Ellipſe and Circle were turned round the Axis A B there would alſo be a Spheroid and a Sphere generated; both which would have the ſame Plane touching them in the point E, becauſe the periphery of a Circle whoſe Radius is D E would be in both their ſurfaces, and the Ellipſis and Circle touch one another in the point E, that is, becauſe the Horizons at E are ſuppoſed to be in the Plane which toucheth the Spheroid and Sphere in that point; both theſe Figures will have the ſame Horizons. The ſame thing is demonſtrated of any other point.

As for his other thought, *viz.* That the Sea ought to be ſeventeen miles deeper at the Equator than at the Poles; he would have done well to have offered us ſome of his abſtruſe reaſons why it ought to be ſo, for a common Reader, that is not uſed to his profound way of thinking, cannot eaſily perceive any, for he will not ſuppoſe without any arguments for it, that the Channel of the Sea is exactly of a Spherical ſurface, but rather think with the reſt of mankind, that it is raiſed after the ſame manner that the ſurface of the Sea is, and is further diſtant from the Center at the Equator than at the Poles.

His next is a very ſtrange thought about Rivers. For (ſays he) if the Earth were of a broad Spheroidical Figure, and if we ſhould ſuppoſe a Canal cut from the Equator to the Poles, it were a paradox to ſay, that the water will not deſcend from the Equator to the Poles; but it would be a greater to ſuppoſe, that Rivers would riſe from thence to the Equator. Well, if this be a paradox, I hope he will thank me if I teach him how to ſolve it.

For the greater eaſe and clearneſs, let us ſuppoſe the matter of the Earth firſt to have been fluid. If this matter had no Centrifugal force, it would ſettle its ſelf into an uniform ſmooth (tho' Spherical) ſurface; but the Earth being turn'd round its Axis, and all the parts of it by this rotation acquiring a Centrifugal force, and thoſe at the Equator having a ſtronger force to recede from their Axis than thoſe towards the Poles; it is evident, that the fluid at the Equator would riſe no higher than that towards the Poles, and the fluid would ſettle its ſelf into a broad Figure; as is here repreſented, [*Fig.* 16. *Plate* VIII.] where, ÆQ repreſents the Diameter of the Equator, P P its Axis.

Now this being the Figure which ariſes from the force of Gravity joined with the Centrifugal force, it is evident, that as long as theſe two cauſes continue to act, this Figure will remain the ſame, and the fluid will not alter its poſition nor deſcend from Æ to P; but that cauſe which firſt brought it into ſuch a poſture, will always preſerve it in the ſame. Or if we ſhould ſuppoſe this Figure alter'd

Plate VIII

Fig. 16. *P. 276.*

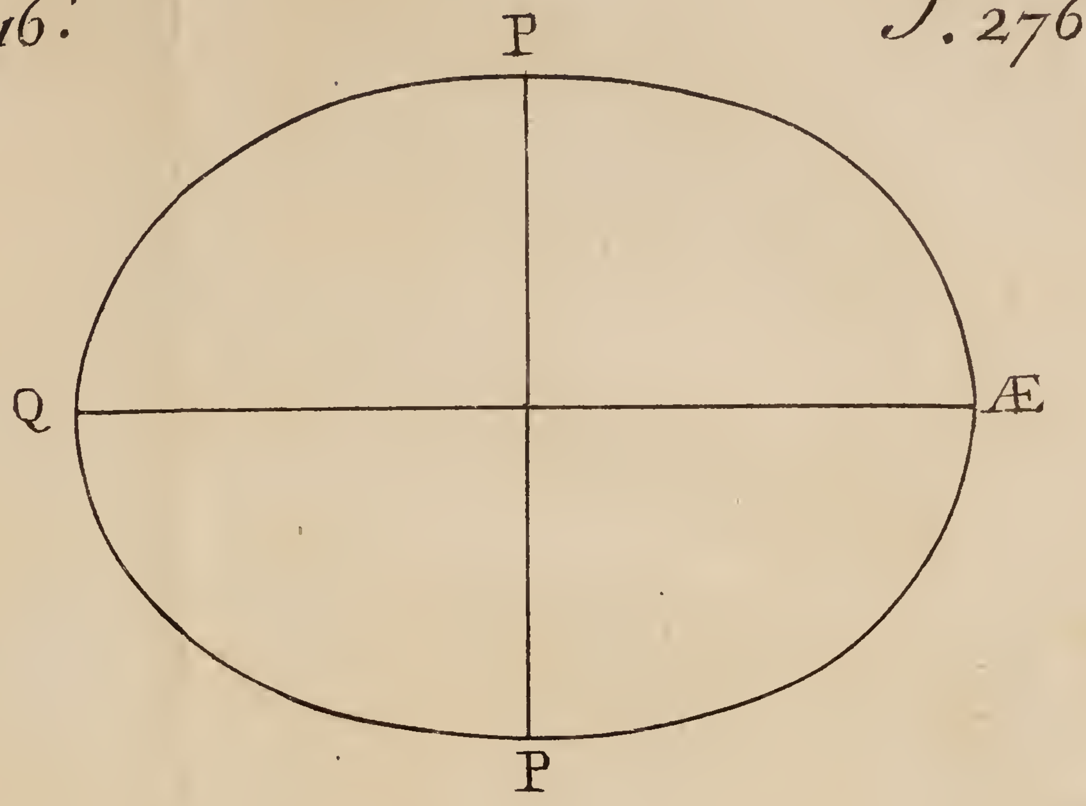
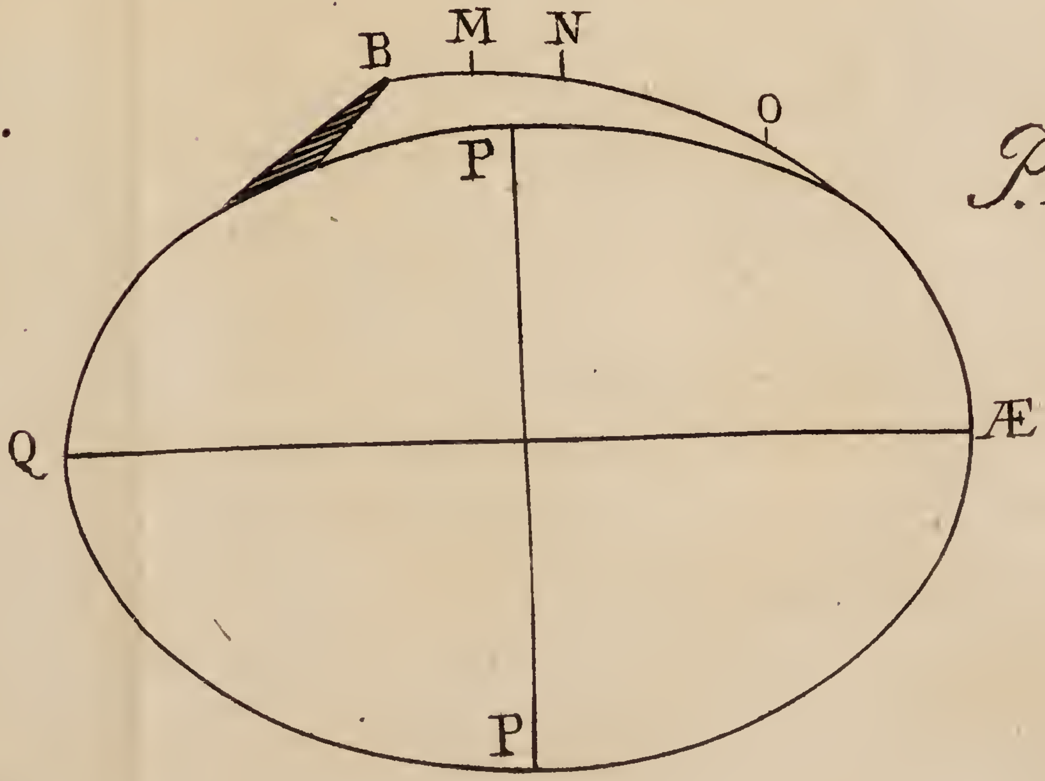


Fig. 17. *P. 278.*



alter'd or chang'd by any external force, ſo that the Diameter of the Equator was made ſhorter; it is evident, that aſſoon as this external force is taken off, that the fluid being acted by the two already mentioned forces, will immediately reſtore its ſelf into its former natural figure; and the parts of the fluid will never come to an equilibrium one with another, till they ſettle ſo as that the Spheroid have the ſame ſurface it had before.

Let us next ſuppoſe this fluid Spheroid to be chang'd into a ſolid one, all except one Channel extended from Æ to P, and as deep as you pleaſe: The fluid in this Channel having the ſame forces to act upon it, according to the ſame direction, and in the ſame manner, will ſtill keep the ſame poſition, without ever changing its figure, and every part will remain in the ſame place that it was in before; it being indifferent to the fluid in the Channel Æ P whether the matter next it be fluid or not fluid, ſolid or not ſolid.

By this, I hope it will appear no paradox to ſay, that if a Channel were cut from the Poles to the Equator, that the water would not run from thence down in this Channel to the Poles. I will next make it appear no paradox, to ſay, that water may be made to run from the Poles to the Equator. It is well known, that (whatever be the Figure of the Earth) water will not run from the Land to the Sea, except the Land be raiſed higher than the Sea, and be made to incline to it. Let us therefore ſuppoſe that B M N O Æ [*Fig.* 17. *Plate* VIII.] were the ſurface of the Land raiſed higher than the Sea, but always inclining to it till it meets with it in Æ. It is plain, that whatever water is at B, will endeavour to approach to the ſurface P Æ as much as it can, and ſettle it ſelf there in its natural figure; and becauſe the point M is nearer to the ſurface P Æ than B, the water muſt move from B to M, but the point N being nearer to the ſurface into which the water does naturally affect to ſettle its ſelf: it is evident, that this water will likewiſe move from M to N; after the ſame manner and upon the ſame account, would the water move from N to O and from O to Æ, it ſtill coming nearer to the ſurface upon which it would naturally ſpread it ſelf, that is, it would move from the Poles to the Equator. Thus, I hope I have made it manifeſt, that it is no great paradox to ſay, that the water will move from P to Æ or from the Poles to the Equator. I have inſiſted more largely upon this point, that it may appear more evident to the *Defender*; becauſe it ſeems he cannot underſtand ſuch reaſonings, unleſs they are made very plain; for I had ſaid the ſame things in the Examination tho' ſomewhat more obſcurely.

Before I leave this ſubject, I cannot but obſerve, that tho' our Author perhaps is very well acquainted with the Antediluvian Geography and the riſe of its Rivers, yet it ſeems that his skill is not very great in the modern. For he makes *Nile* in *Africk* to croſs the line, whereas if he had conſulted the modern Geographers and their obſervations, he had ſeen that the *Nile* riſes ſome degrees on this ſide of the line, as it is to be ſeen in *Ludolphus*'s Map of *Æthiopia.*

After this fine diſcourſe of our Authors about the aſcending of Rivers towards the Equator, to conclude the argument he ſays, that if this difference of Pendulums were found, it will ſtill bear a diſpute from what Phyſical cauſes it proceeds. He indeed may diſpute it, and perhaps will never come to know it as long as he lives, but I believe very few elſe will ever doubt, but that it proceeds from a greater Gravity in the one place than there is in the other; eſpecially ſince it can be prov'd from demonſtrative principles, that if there be two Pendulums of equal lengths that perform their Vibrations in unequal times, that the Gravity where the ſwifteſt Pendulum Vibrates, is greater than where the ſloweſt is. This I ſay can be demonſtrated from moſt evident and Geometrical principles; and if the *Defender* does not underſtand them, it will be his wiſeſt courſe to ſuſpend his judgement till he has learn't as much of the Elements of Geometry and Mechaniſm, as will qualify him to comprehend them.

I not only prov'd this variation of Gravity, from its effect upon Pendulums, but I alſo ſhew'd the cauſe of it, and that it muſt be ſo, upon ſuppoſition, that the Earth turns round its own Axis. For all Bodies that turn round an Axis, endeavour to recede from that Axis; and becauſe at the Equator Bodies moved ſwifteſt, the Circles there being greateſt, this *Conatus* or Centrifugal force would be alſo greateſt; now this force at the Equinoctial acting directly againſt the force of Gravity, (which it does no where beſides) it is evident, that upon this account Gravity muſt be leſs there than any where elſe. Upon the account of this diminution of Gravity it muſt follow alſo, that the Diameter of the Equator will be greater than its Axis, or that the Matter at the Equator riſes higher than at the Poles.

The *Defender* ſays, that this is agreed and own'd on all hands, in caſe there were no impediment to hinder the riſing or retroceſſion of the middle parts; but (ſays he) the *Theoriſt* did believe, that the Vortex was of a ſhorter Diameter there than thro' the Poles, which hindred the riſing of the fluid. What this impediment is, or what ſhould occaſion this ſtraitneſs of the Orb at the Equator I know not; I hope the *Theoriſt* does not ſuppoſe that there is a great iron hoop at thoſe parts, a ſolid ring like that of *Saturns*, which keeps in the fluid from riſing. Yet how it ſhould be elſe kept in is beyond my skill to gueſs; I wiſh he would explain this more at length, that we might know what he means by it.

But let us ſuppoſe this ſtraitneſs of the Orb at the Equator, and ſee what will follow from it; [*Fig.* 18. *Plate* IX.] Let A C B repreſent the Earth, firſt of a Spherical Figure: E F G H a fluid Orb of Air which ſurrounds it, which we will ſuppoſe ſtraiter at F than at E and G; Let A B be the Axis of the Earth, becauſe the matter of C has a greater endeavour to recede from the Center than the matter any where elſe upon the Earth; it is evident that this matter muſt preſs ſtronger upon the fluid immediately above it, than the matter at other parts can do upon the fluid immediately above them; and becauſe the matter of the Earth is much more ſolid than the fluid Air, it is plain, that the *Vis motrix* or abſolute force that the matter of the Earth has to recede from the Center, will be greater than the abſolute force that the Air has to recede from its Center; it is plain upon this account, that the Air muſt yeild to it; but according to the *Theoriſt* the Air cannot riſe higher than F, therefore it muſt recede towards E and G, and leave room to the matter at C to riſe up to M; by which means it is evident, that (this matter thus riſing at the retroceſſion of the fluid Air) the ſolid matter of the Earth muſt ſettle its ſelf in the form of a broad Spheroid. Thus, from the *Theoriſts* own principles and ſuppoſitions, I have prov'd that the Earth muſt be higher at the Equator than at the Poles.

The Author tells us, that thoſe who affirm that the Earth is in form of a broad Spheroid, will allow of no *Vortices* to the Planets; but then (ſays he) they muſt aſſign ſome other ſufficient cauſe to carry the Planets in their Periodical motions with the ſame velocity for innumerable Ages about their common Center; and the Secondary about the Primary; as alſo what gives them their diurnal rotation, and the different poſition of their *Axes*.

I thought that this *Defender* had been better acquainted with the hiſtory of Philoſophy for theſe twelve years paſt, than it ſeems he is. One would think that he had done nothing but por'd upon the Theory all this time, ſince he is not acquainted with what is known to every body that pretends to Philoſophy now a days.

He may find ſeveral hundreds of people that can tell him, that there are other cauſes found for the Cœleſtial motions than the *Vortices*, which will eaſily explain all thoſe *Phænomena* he has juſt now mentioned. The cauſes why the Planets move in Elliptical Orbits are now diſcover'd; it is known why they move ſwifteſt at their *Perihelia*, and ſloweſt at their *Aphelia.* The cauſe of the proceſſion of the Equinox is now no longer a myſtery; and (which is for our purpoſe) it depends upon principles that ruin the *Theoriſt's* Figure of the Earth, and aſſert the direct contrary, making it in the form of a broad Spheroid.

The motion of the Moons *Apogeon* forward and of its *Nodes* backwards, its variation, and all its other motions, are eaſily accounted for by the ſame cauſes, none of which could ever be made out by the *Vortices.* For by them we can't anſwer the firſt queſtion the *Defender* puts, *viz.* What is it that carries the Planets round the Sun with the ſame velocity for many Ages? Nay, ſuppoſing that we were altogether ignorant of any other cauſe, yet it is no hard matter to prove, that the *Vortices* can never be the cauſe of the Cœleſtial motions; and therefore there being no *Vortex*, there can be no ſuch thing as a ſtraitneſs in the Orbit at the Equator, which the *Theoriſt* and the *Defender* ſuppoſe. But if I ſhould allow them both their *Vortices* and the ſtraitneſs of their Orbs, I have already prov'd, that they will ſignify nothing to their purpoſe.

The *Defender* tells us, that this reaſoning about the Figure of the Earth depends upon the *Theoriſt's* Hypotheſis, that the Globe of it was once fluid; and from thence he pretends to confirm the Theory: *For* ſays he) *neither Figure of the Earth, oblong or oblate, can be prov'd from the rotation of the Earth and its Gravity, without ſuppoſing the Globe formed into that ſhape before it came to be loaded and ſtiffned with Rocks and ſtony Mountains; and therefore upon both Hypotheſes it muſt be allowed, that there was ſuch a time; ſuch a ſtate of the Earth when its tender Orb was capable of theſe impreſſions and modifications, and that Orb muſt have lyen above the waters not under them, nor radicated to the bottom of them; and in the laſt place, this concretion upon the waters* (ſays he) *muſt have been throughout all the parts of the Earth, for there is no reaſon why one part of the fluid ſhould be covered more than another; ſo* (ſays he) *that in effect we muſt ſuppoſe, that all the watery Globe was at firſt covered over with an Earthy concretion: Now this being admitted* (ſays he) *we have confirmed the main point of the Theory, namely, that the Abyſs was at firſt covered over with an Orb of earth; and if we will grant him this he will compound for the reſt.*

He is a little too unreaſonable in expecting grants of ſuch things as are altogether precarious, and affirm'd without ſo much as a ſhew of an argument. My buſineſs was to prove, that he had deduced a wrong concluſion from his own Hypotheſes and Principles; and therefore, ſuppoſing that the Globe of the Earth was once fluid, I prov'd from thence, that it muſt have ſettled it ſelf into the figure of a broad Spheroid, and not of an oblong one.

But yet I demonſtrated, that ſuppoſing the Earth to have been partly fluid and partly dry, as it is at preſent, that even in that caſe, the Figure of the Earth muſt be Spheroidical, becauſe we obſerve that the Land is very nearly of the ſame Figure with the Sea, (only raiſed a little higher, that it may not be overflowed) and compoſes with it the ſame ſolid, but the Sea being fluid will ſettle its ſelf into juſt ſuch a figure, as if the whole Globe were fluid, that is (as I have demonſtrated) its ſurface will be the ſame with that of a broad Spheroid; and therefore the Land which is of the ſame figure will be ſo likewiſe. And thus I hope I have prov'd, that whether we ſuppoſe the Earth to have been at firſt entirely fluid, or to have been compos'd of parts ſome ſolid and ſome fluid, that from either of theſe ſuppoſitions it follows, that the Figure of the Earth muſt be directly contrary to what the *Theoriſt* aſſigns.

But (ſays our Author) if the Earth was from the beginning in this preſent form, firm and ſolid, (as it is now) Rocky and Mountainous, then the queſtion is, how the Parts or Regions of the Earth about the Equator, could be raiſed above a Spherical figure or into an oblate Spheroid; ſuppoſe then the waters raiſed by the circumvolution of the

Earth, how was the *Terra firma* raiſed, or how could it be raiſed by that or any ſuch cauſe. Theſe queſtions (ſays he) are no matter of difficulty to the *Theoriſt*, who ſuppoſes the firſt Earth to have covered the Waters, and to have taken their ſhape (whatever it was) as upon a mould.

However eaſy they may be to the *Theoriſt* I aſſure him that they are much eaſier to me, who ſuppoſe that God Almighty raiſed the Land at the beginning, when he form'd the Earth into the Figure it has at preſent, which otherwiſe could never have riſen of its ſelf. The dry Land therefore was raiſed and formed into a Spheroidical Figure by its wiſe Creator, on purpoſe that it might not be overflow'd by the Sea at the Equator, which (as I have prov'd) muſt of neceſſity have been higher there than at the Poles; and therefore if the Land at the Equator had remain'd in a Spherical Figure, no higher than that which is at the Poles, the Sea muſt of neceſſity have riſen above it, and ſpread its ſelf upon it like an Inundation. It was therefore wiſely order'd by the Divine Providence, that not only the Sea but the Land alſo ſhould be form'd into a broad Spheroidical Figure, on purpoſe that it might not be overflow'd with Waters.

That the Readers might obſerve the *Theoriſt*'s great skill in drawing of conſequences, and how well his Oval-figur'd Earth was ſupported with reaſons; I gave them his argument thus, *All bodies by reaſon of the Earths diurnal rotation, do endeavour to recede from the Axis of their motion, but by reaſon of the preſſure of the Air, and the ſtraightneſs of the Orb, they cannot recede from the Axis of their motion, therefore they will move towards the Poles where they will come nearer to the Axis of their motion, that is, Becauſe all bodies endeavour to recede from the Axis of their motion, therefore they will endeavour to go to the Axis of their motion.* In anſwer to this, the *Defender* ſays, that the *Theoriſt* aſſerted, that all Bodies did *conari à centro ſui motus recedere*, which I have render'd, endeavour to recede from the Axis of their motion; and by changing the word Center into Axis, of plain ſenſe (ſays he) I have made non-ſenſe; and then he is ſo free as to own, that the concluſion will follow from my own words, but not from thoſe of the *Theoriſt*. I own, that I chang'd the word Center into Axis, not careleſly but willfully, with a deſign not of making it non-ſenſe, but better ſenſe than it was before. For we never ſay that a Sphere turns round about its *own* Center, for that would be plain non-ſenſe indeed, but round about its *own* Axis; for we cannot ſo properly ſay, that a Body moves round a Center as round an Axis, unleſs we abſtract from its Magnitude, and conceive it as a point. The reaſon is plain, for when any Body revolves, it is evident that every point of it which does not lye in the Plane of another points Orbit, muſt deſcribe a different Periphery, which muſt have alſo a different Center, ſo that all thoſe Centers are placed in one line, which is therefore call'd the Axis of the Bodies motion; about which, Bodies are ſaid to revolve much more properly than about a Center: however, this Author ſays, that by changing the word Center into Axis, of plain ſenſe I have made non-ſenſe. This Gentleman ſeems to be ſo extreamly paradoxical, that I have often ſuſpected he muſt have a different method of judging what is ſenſe or non-ſenſe from other people, if he has it, it were but fair to ſhew it, that we may know when things will be agreeable to his *Criterion*, or when they will not; if he thinks it non-ſenſe to ſay, that Bodies do endeavour to recede from the Axis of their motion, it is my comfort to have ſome good Mathematicians on my ſide, who think otherwiſe: I need only mention one of them, whoſe very name is enough to defend me, *viz.* The greateſt Geometer and Philoſopher of the Age, who uſes this way of ſpeaking very often in his *Philiſophiæ Naturalis principia Mathematica*, for which he needs go no further than *page* 8. where it is ſaid, *Gyrantium partes omnes conantur recedere ab Axe motus.*

But however, let us reaſſume the word Center, and ſee if the argument will appear more plauſible, or ſeem to conclude better than it did by uſing the word Axis: *All Bodies by reaſon of the Earths diurnal rotation, do endeavour to recede from the Center of their motion, but by reaſon of the preſſure of the Air and the ſtraitneſs of the Orb, they cannot recede from the Center of their motion, therefore they will go towards the Poles, and move in a Circle where they will be nearer the Center of their motion.* I hope I have not now chang'd his words, but have delivered his true meaning; I leave the Reader to judge if it is not excellently well concluded, and if the connexion be not ſo evident, that it needs no Comment to make it out.

Now ſuppoſing, that the *Theoriſt* had reaſoned well all this time about the Earth, and had deduced its true Figure from its true cauſes; yet I demonſtrated, that all this will not make Rivers run from the Poles to the Equator, for a reaſon that I will take the liberty here to repeat, that we may compare it with the *Defenders* anſwer; The demonſtration is this:

The Rotation of the Earth round its own Axis being ſtill the ſame, the cauſe which thruſt the water from the Equator to the Poles, will alſo continue the ſame and invariable, and by conſequence it will hinder the water from returning again towards the Equator; and therefore, ſuppoſing that the Earth was formed into an Oval-figure, yet there could not be any courſe for the Rivers;

for only ſo far would the water aſcend towards the Poles, till the force which protruded it that way, came to be in *Equilibrium* with its Gravity, and there it would ſtop, neither aſcending farther or deſcending again, as long as the ſame cauſe continu'd to act; that is, ſo long as the Earth turn'd round its own Axis in the ſpace of twenty four hours. But if the Earth ſhould ceaſe to move round, then indeed, in that caſe and no other, would the water return to the Equator. For let the figure P Æ P Q [*Fig.* 19. *Plate* IX.] repreſent the Earth, P P the Poles, Æ Q the Equator, B a body upon the ſurface of the Earth. I think it is evident, that the body B will ſo far aſcend towards the Poles, till the force that protrudes it that way, be in *Equilibrium* with the force that draws it to the Equator. For if at B one were greater than the other; for example, the force which draws it towards the Poles, were greater than its gravity or its tendency towards Æ, then it would ſtill move towards the Pole, till both forces come to act equally, and there it would reſt as long as theſe two forces continued in *Equilibrium*, which muſt be ſo long as the Earths diurnal motion laſts; now whatever Bodies either ſolid or fluid, are brought and lay'd upon the ſurface of the Earth at B, theſe being drawn or puſht with the ſame accelerating force either to the Pole or to the Equator, that the firſt fluid had which

Plate IX

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Fig. 18.

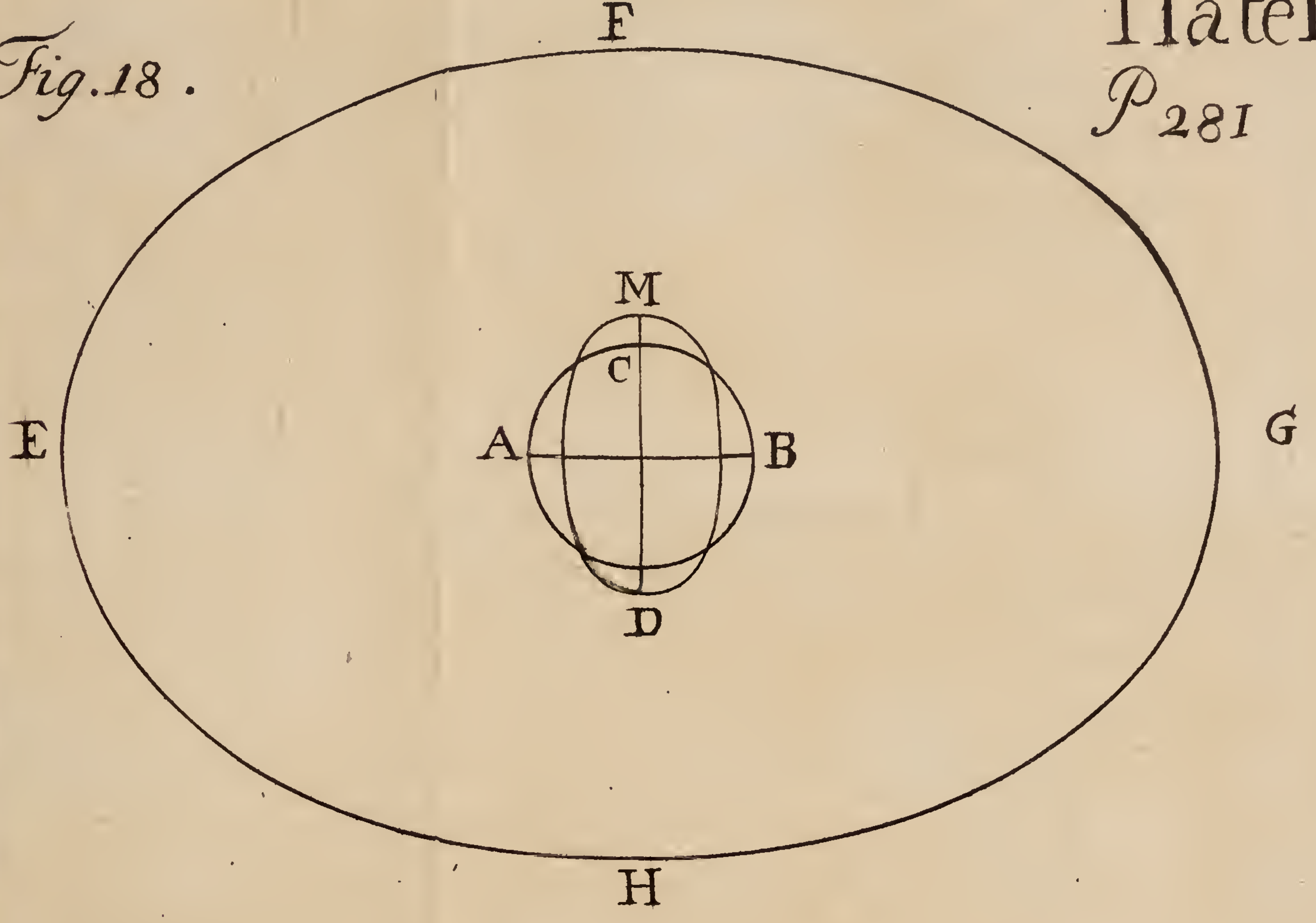
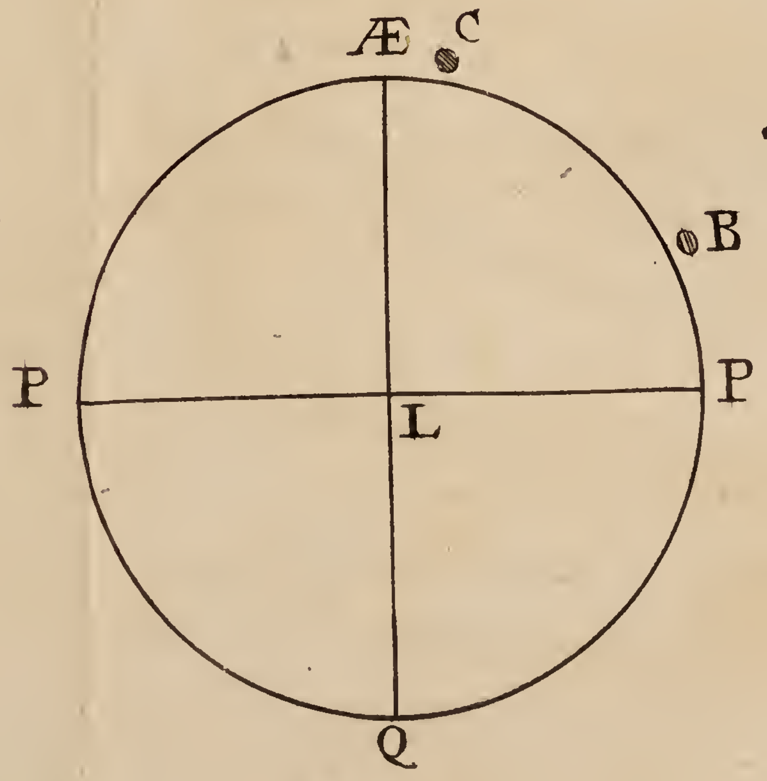


Fig. 19.

P. 290.



which was conſtituted at B, the ſame cauſes continuing to act upon both, they will reſt there alſo, and conſequently will not deſcend to the Equator.

The *Defender* thinks he has tranſcrib'd this reaſon very briefly thus; *The ſame cauſes which caſt the Abyſs or the Ocean towards the Poles, will alſo keep the Rivers from deſcending from the Poles*; and then he anſwers, *that there is no parity of reaſon betwixt the Abyſs or the Ocean, and the Rivers. We ſee* (ſays he) *in the flux and reflux of the Ocean, it hath not that effect upon Rivers nor upon Lakes, nor upon leſſer Seas, yet the circumrotation of the Earth continues the ſame:* He adds, *That my confounding the Ocean and Rivers in the Antediluvian Earth is ſo much the worſe, ſeeing there never was an Ocean and Rivers together in that Earth*; *while* (ſays he) *there was an open Ocean there were no Rivers, and when there were Rivers there was no open Ocean, but an incloſed Abyſs*; He concludes at laſt, *That tho' I make large tranſcripts there and elſewhere out of the Theory, yet I do not ſeem always to have well digeſted the method of it.*

I hope the Reader will obſerve how unfairly this Author is pleaſed to deal with me, for in all the argument I have not ſo much as once mentioned the Ocean: but the demonſtration was univerſal and reach't all ſorts of Bodies, whether they be in the Abyſs or on the ſurface of the Earth. My words were, that whatever Bodies either fluid or ſolid, if brought and lay'd upon the ſurface at B, being drawn or puſht with the ſame accelerating force, that the firſt fluid had which was conſtituted at B, the ſame cauſes continuing to act upon both, they will reſt there alſo, and not deſcend to the Equator. Where is it now that I have confounded the Ocean with the Rivers? Or is there any thing in theſe words, by which it appears that I have not digeſted the method of the Theory? There is one of this Authors acquaintance, that is pleas'd to tell us, that diſingenuity in examining the Writings of another Perſon falls more heavy in the conſtruction of fair Readers, upon him that uſes them, than upon him that ſuffers them: If it be ſo, this Gentleman may eaſily know, what theſe Readers will think of him. *Reflections page laſt line laſt.*

However, it ſeems he thinks, that tho' none of the water return'd to the Equator while the Earth was at firſt fluid, and had put on its Oval-ſhape, yet when the firſt concretion was ſettled upon it, whatever water was after that upon its ſurface, would then deſcend towards the Equator. Why ſo I pray? What reaſon does he give for this? Had not the fluid which lay at B, the very ſame cauſes to keep it from deſcending to the Equator, that it had before, when the Earths ſurface was all fluid? Was not there the ſame diurnal rotation of the Earth, in the ſame time, and by conſequence the ſame Centrifugal force? Was there not the ſame preſſure of the Atmoſphere, and the ſame ſtraitneſs of the Orb that was before? And in a word, every thing the ſame that kept it from deſcending in the former caſe, would alſo preſerve it in this in the ſame poſition, what reaſon then can this Author give us for this aſſertion? Indeed, he offers us none; if he has any, he keeps it as a ſecret, which it ſeems he will not communicate but to his friends. I think he will do well to keep it ſecret for ever.

But, tho' he will neither ſhew us his own reaſons nor anſwer mine, yet that we may not be altogether diſſatisfy'd, he is pleaſed to give us a ſimilitude to explain it: "We ſee (ſays he) in the flux and reflux of the Ocean, (let the cauſe be what it will) it hath not that effect upon Rivers, nor upon Lakes, nor upon leſſer Seas; yet the circumrotation of the Earth continues the ſame." *Pag.* 55. 56. Is there any parity of reaſon here between the flux and reflux of the Sea, and the deſcent of the fluid to the Equator? Or does he think that the flux of the Sea ariſes only from the rotation of the Earth? If he had ſtudy'd true Philoſophy but half ſo much as he has done the Theory, he might have known that the Tides of the Sea are cauſed by the action or attraction of the Moon upon it; and becauſe one part of the Ocean (being directly under the Moon) is more attracted by it than the reſt, the Ocean there muſt ſwell, and the water will run from the other parts of it, unto the place which is moſt attracted. Now in Rivers, Lakes, and narrow Seas, there being no difference of attraction in any of its parts, (they being all ſo narrow that the Moon cannot act ſtronger upon one ſide of them than the other) it is plain, that no part will ſwell more than another, and the waters will not riſe higher, nor move from one place to another, by reaſon of this equal attraction.

Perhaps, this may be a little obſcure to this Author, who as it ſeems does not underſtand the true cauſe of our Tides; but it not being my buſineſs to explain theſe things at large, I will refer him to an excellent diſcourſe of Mr. *Edmund Halleys*, which he made to K. *James*, when he preſented him Mr. *Newton*'s Book of the Principles of Natural Philoſophy.

He tells his Reader that I ought to have given a better notion of *Centrifugal force* than what I have done; For he quotes page 91. of the Examination, where it is ſaid, that the Centrifugal force or that force by which a Body is drawn towards the Center; and in the next Page it is ſaid, that by this Centrifugal force Bodies endeavour to recede from the Center of their motion, which is true, but contrary to what I ſaid before.

He needed not have gone ſo far as the 2d. line of the next page, to have found out the true notion of a Centrifugal force; for if he had repeated the words immediately following his firſt quotation, he might there have found it. But if he had done ſo he had loſt his aim, and the Reader would have perceived that it was not a confuſion in my notions, but only a fault of the Preſs. I will here repeat the ſentence, that the thing may be ſet in its true light, *If a Body* (ſaid I) *revolve freely in a Circle about a Center, as the Planets do about the Sun, its Centrifugal force, or that force by which it is drawn towards the Center, will be always equal to its Centrifugal force by which it doth endeavour to recede from the Center.* A candid Reader would have immediately imputed this to nothing elſe but a fault in the Printing, and inſtead of the firſt word *Centrifugal force*, he would have ſeen that the word *Centripetal force* ought to have been put, as the very ſenſe would eaſily have directed any one that had the leaſt acquaintance with this ſubject.

After this the *Defender* tells us, that I might have ſpar'd what I have tranſcrib'd from other Authors, about calculating the diminutions of Gravity made by the Centrifugal force in different Latitudes, theſe being needleſs to the confutation of the Theory. Why ſo I pray? Are they not to the purpoſe? Or do they not anſwer the intended deſign, which was to find out by a Calculus the difference of Gravity in different Latitudes, and from thence to confirm our Hypotheſis, by comparing Calculations with Obſervations, and ſeeing how the one agrees with the other? Well, but I am blam'd for tranſcribing them from other Authors. I hope he does not think them the worſe for that; or that I ought not to make uſe of them as arguments againſt his Theory, becauſe they were ſaid by others. He might indeed have juſtly blam'd me, if I had publiſhed them as new notions or inventions of my own, and told the Word *I expected thanks for the diſcoveries*, as a late Author has done; but I pretended to no ſuch thing.

It is well known that Mr. *Newton* was the firſt that made the diſcovery, and ſhew'd the method of Calculating the Gravity of Bodies at different Latitudes, whom therefore I mention'd as the ſole Inventor. Mr. *Hugens* indeed I did not name, ſeeing he had the notion entirely from Mr. *Newton*, as that learned Gentleman does freely acknowledge. But after all this, I have not ſo much tranſcrib'd from theſe two learned Authors, as I have endeavoured to explain their notions, and make them intelligible to Men of lower capacities.

Thoſe two excellent and learned men, had ſomething elſe to do, and matters of greater concern to mind, than to publiſh their diſcoveries at large, ſo that every Reader might underſtand them. I thought therefore that it would not be altogether diſpleaſing to the World, if I endeavoured to explain their Theorems about the Figure of the Earth, and the effects of Gravity join'd with a Centrifugal force; ſo that they might become intelligible to thoſe who underſtand the Elements of Geometry and the common principles of Staticks: and I doubted not but it would be more acceptable, becauſe there has not (at leaſt to my knowledge) been any diſcourſe publiſhed of this nature in *Engliſh*.

Without doubt the Reader does now perceive, how vain, empty, and incoherent, a piece of Philoſophy this Theory is; its principles are falſe, ſuppoſitions precarious, and the reaſonings upon them, are all along ſo weak and ill grounded, that it is hard to think that the *Theoriſt* himſelf can give any credit to it; and yet (which is ſtrange) he profeſſes that he believes it more than he does the *Moſaick Hiſtory* of the Creation; tho' there is this great difference between them, even ſuppoſing no inſpiration in the caſe, that there is nothing in the account that *Moſes* gives, but what is really poſſible; for according to him the whole was perform'd by the immediate hand of God Almighty, who needs not the help of ſecond cauſes for ſuch a work; whereas the *Theoriſt*, who would have it ariſe from Natural and Mechanical principles, always aſſigns ſuch cauſes as are utterly inſufficient for the propoſed effect, and generally ſuch as would really produce the contrary.

But if after all, the *Theoriſt* will ſtill inſiſt upon the truth of his Theory, and has no mind to prove it himſelf; I would adviſe him to find out ſome new *Defender*, who can underſtand, and conſider the force of an argument ſomewhat better, than his laſt ſeems to have done, who (as it appears) has not ſo much defended the Theory, as expos'd its nakedneſs and his own unskilfulneſs.

However, ſince the *Theoriſt* has ſuch a high opinion of his own performance, and ſo mean a one of the account given us by *Moſes*; before I end this diſcourſe it will not be amiſs, to examine a little the notion he has given (in his *Archæologiæ* Book II. Chap. 8. 9.) of the *Moſaick Hiſtory* of the Creation. Which in ſhort is this, That we are not to believe the firſt Chapter of *Geneſis* in a literal ſenſe; but that *Moſes* receded from the *Phyſical verity*, as he calls it, and ſpoke only λαοδογματικῶς, that is in plain *Engliſh*, there is not a word of it true, the World being neither Created nor Formed in the manner there recorded; but that his Hiſtory of the Formation of Heaven and Earth was not contriv'd to be agreeable to the truth, but to the notions and diſpoſitions of the people for whoſe uſe it was written.

Archæol. p. 317.

To make this out, he pretends to find many faults and incongruities in that Hiſtory, which I need not now particularly conſider; ſince there is none of them that is really incongruous and diſagreeable, either to the Nature of things or the Wiſdom of God, but only to his notions, and ways of thinking: As for inſtance, when he ſays (and he tells us that he ſpeaks it with indignation) that without the greateſt reproach both to the Work and its Maker, it is neither to be ſaid or imagined, that this Earth which he ſtiles the very dregs and excrements of nature, ſhould be the chief and principal part of the Creation, and the firſt born of every Creature, ſo that there ſhould be more time allow'd for the framing and ordering of it, than what is beſtowed on all the reſt of the World. *Archæol.* p. 299.

However great the *Theoriſt*'s indignation is, that he has conceiv'd upon this account, I am ſure there are ſome that cannot read thoſe Reflections of his upon this Hiſtory, without a much greater. It may be ſuppos'd that *Moſes* who had an immediate converſation with God Almighty, knew better what was a reproach to the World and its Maker than the *Theoriſt* does, and yet we find that he thought it no affront to the Divine Wiſdom, not only to ſay and imagine ſuch a thing, but alſo to write it, and that with a deſign, that it ſhould be received as true by all future generations.

Archæol. p. 318. But ſays the *Theoriſt*, the Sacred Writers do often ſpeak in a Myſtical, Allegorical, or Metaphorical ſtile, and according to the capacity of the people, and why might not *Moſes* do the ſame in delivering the Hiſtory of the Creation. To anſwer this, let us conſider in what caſes the Scriptures are to be taken, not in a literal but in an Allegorical and Metaphorical ſenſe, and then compare each of them with the preſent caſe, to ſee if there is any parity of reaſon between them.

Firſt then, the Scriptures are to be underſtood in an Allegorical ſenſe, when their literal meaning would imply a contradiction, either to ſome other place of the Sacred Writings, which is moſt evidently to be underſtood literally; or to the nature of the things ſpoken of; thus when God Almighty is ſaid to have hands and feet, ears and eyes, to move and walk, and to have the affections and paſſions belonging to Men, all or any of theſe ſince they are a contradiction, to the Infinite perfections of the Deity, can never be underſtood in a literal meaning; tho' there ſhould be ſtill ſome ſort of analogy between them and the thing ſignified. We are ſure, that this conſideration can have no place in the *Moſaick Hiſtory* of the Creation, which moſt certainly does neither contradict any other part of the Scriptures, nor is there any thing ſaid there but what is plainly poſſible, and can be performed by the Power of God, who if he had pleas'd, could have formed the World or any part of it (how great ſoever) in an inſtant.

In the next place, the Scriptures are not to be taken in a real and literal meaning, when they ſpeak according to the ſyſtem of appearances, and the notions which we draw from our ſenſes; Thus, when it repreſents the Earth plain, and as having four Corners, with the Heavens ſtretched over it like a Curtain. In thoſe indeed, and in many other ſuch like places in Scripture, it is certain, that it was the deſign of the Sacred Penmen, not to ſpeak according to the reality and nature of the things themſelves, but according to the notions and opinions which people received of them from their ſenſes; or indeed when the Sun is ſaid to move every day from Eaſt to Weſt, to Riſe and Sett, to ſtand ſtill, there is no neceſſity of imagining that all thoſe things are really perform'd by the Sun; but there the holy Pen-men, as all other Writers which do not concern themſelves with Aſtronomy, ſpeak according to the ſyſtem of appearances, and as the Heavenly motions are repreſented to them by their ſenſes, it being the common and receiv'd way of ſpeaking from which we are not to recede, if we deſign to be underſtood; and even all thoſe Aſtronomers who firmly believe the motion of the Earth, when it is not their buſineſs to explain the true ſyſtem of the

Univerſe, are forced to ſpeak in the ſame Dialect: and I believe we ſhould ſcarce think a Man right in his wits, that in writing or ſpeaking upon any common ſubject, inſtead of ſaying that the Sun roſe and ſet, or that it came to the Eaſt or went to the Weſt of us, would ſay, that our Horizon moved till it came above the Sun or went under it, or that our Horizon turned round till the Eaſt or Weſt points of it came to be exactly under the Sun.

Now this can never be apply'd to the *Moſaick Hiſtory* of the Creation, ſince the method of the Formation of the World could never have appeared to our ſenſes, and without a Divine Revelation, we ſhould have been ignorant of it to this day, and had never diſcover'd the order and method by which all things were form'd. *Moſes* certainly wrote that diſcourſe on purpoſe to give us a true notion of the Creation, and therefore was to ſpeak of things as they were really formed, without any reſpect had to appearances as they would be repreſented to humane ſenſes; ſince there was no Man then in being to whom they could have appeared, and I am of the opinion, that if he had purpoſely and directly wrote as much, upon the Syſtem of the World and the motions of the Heavens, as he has done upon the ſubject of the Creation, all thoſe who acknowledge the Divine Authority of his writings, would have been oblig'd to believe it.

The next caſe, wherein we are to recede from the literal ſenſe in the interpretation of Scripture is, when they deliver parables; thoſe being only contriv'd by their Writers to illuſtrate ſomething wherein they would inſtruct the people, can never be ſuppos'd to be underſtood in a literal meaning.

This way of writing is indeed very ancient, and is of great uſe for informing Mankind in the precepts of Prudence and Morality, which are never ſo eaſily retain'd, or ſo ſtrongly imprinted on our imagination, as when they are couched under ſome Fable, whoſe Moral is eaſily apprehended. But then from the nature of thoſe Parables, and the manner of their delivery, it is eaſy to perceive, that their Authors never deſign'd they ſhould be received as true Hiſtory; all their aim was, that we ſhould attend to the Moral, for the ſake of which the Parable was contriv'd; this is plain from the Parable of *Jotham* of the Trees chooſing themſelves a King, and from all the Parables of our Saviour.

But the Hiſtory of the Creation is a very different caſe from any of them; *Moſes* does not give it us as a Fable, only contriv'd for the ſake of ſome Moral meaning which he would have thereby underſtood, but delivers it ſeriouſly as matter of fact, which he would have us believe as firmly and truly as any other part of his Hiſtory; and this a Man of integrity could never have given himſelf leave to do, had he not been ſatisfied that the Hiſtory was exactly true.

But if the *Theoriſts* Hypotheſis about the *Moſaical Hiſtory* of the Creation were true; it ſeems that *Moſes* muſt have been guilty of impoſture in a very high degree, for he ſuppoſes that Hiſtory to have been abſolutely falſe, and without any foundation in the reality of things, and at the ſame time freely owns, that *Moſes* wrote it with a deſign that it ſhould be received as true, not by one Man only, but by a great and populous Nation, and that not for one Generation, but through all ſucceeding Ages; this I take to be ſtrange doctrine, and no ways agreeable to the high eſteem we owe either to that great Prophet, or to the Veracity of that unerring Spirit that aſſiſted him in writing.

But it is the *Theoriſts* opinion, that *Moſes* thought it neceſſary to give the *Jews* a *Coſmogonia*, a Theory of the Earth, each of their neighbouring Nations (as he gueſſes) had one of their own, which were generally erroneous and inconſiſtent with the true Religion; and if ſo, ſome of them might have had his Theory for ought we know; now he thinks, that without doubt the *Jews* had taken one from them, or had made one for themſelves, unleſs they had been otherwiſe provided by *Moſes*; * he illuſtrates this with a very decent ſimilitude, if you do not get a Husband for your Daughter, ſhe will find *Pag.* 320. 321.

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* *Si nuptam non dederis filiam, ipſa ſibi maritum quæret è famulis forſan aut humili plebe.*

one for her ſelf, your Foot-man perhaps, or ſome one as mean.

Well, but ſince the *Jews* were to have a *Coſmogonia*, why ſhould they not have been taught the true one? O ſays the *Theoriſt*, that was by no means fitting, for they were an ignorant, indocible people, and could never have been taught true and ſolid Philoſophy, ſuch as his own Theory is; For let us feign ſays he, at leaſt (and 'tis but feigning at beſt) that our Theory is true, let us ſuppoſe the Primitive Earth to have been made in the ſame form and manner as is deſcrib'd in the Theory; had not *Moſes* ſpent his time well in teaching ſuch Philoſophers? Can we ſuppoſe that thoſe Brick-makers, thoſe who ſtill ſmelt ſtrong of the Oinions and Garlick of *Egypt*, thoſe who could not diſtinguiſh a Molten Calf from God Almighty; can we (ſays he) ſuppoſe, that ever they could have learnt the true principles of things, or the Laws of nature and motion? to have deliver'd thoſe things to them, would have been to caſt Pearls before Swine.

The *Theoriſt* may have as great thoughts of his Theory as he pleaſes, but it is my humble opinion, that there is very little skill required, either in the Laws of motion or Natural Philoſophy, to underſtand it, as well as he himſelf does: there is no neceſſity of a long proof for this, ſince we are ſure there are ſome, that have not only read it, but even ſtood up in the Defence of it, that ſeem to underſtand as little of real Philoſophy, and leſs of Mechanicks, than the moſt ignorant of his Brick-makers.

Pag. 319. Let us now aſſume the ſame liberty with the *Theoriſt*, that he has done with *Moſes*, and let us ſuppoſe that the *Theoriſt* ſhould get a Congregation of *Jews*, who I believe are ſtill as dull as ever they were, and ſhould begin to Harangue them thus.

Be it known unto you Men, Brethren, and Fathers, That this Earth which we now preſs with our feet, and find ſo firm and ſolid under us, was once a fluid *Chaos*; that is (that I may adapt my diſcourſe to your low capacities) a medly, or a confuſed Maſs of Earth, Water and Air, mixed and blended together: How it came to be ſo, or how long it continu'd in that ſtate, I know as little as you do; only I am ſure that it was once ſo, and I would have you take my word for it; at laſt, this diſorderly Maſs came to ſettle, and all Bodies took their place according to their weight, the great heavy Bodies fell loweſt, and compoſ'd the innermoſt ſolid; next to them the Water took its place, and over it the Oil ſpread it ſelf, above all there was a huge thick Orb of Air, full of mud and earthy particles, thoſe by degrees fell down upon the ſurface of the Oil, and at firſt made a thick ſlime, which thro' time began to harden, and compoſe a firm and ſolid Cruſt, over the face of the Waters; that was able to ſuſtain the weight of all the reſt of the deſcending particles.

What deep reach of thought is requir'd for the underſtanding of this? How many, and what are the Laws of nature and motion that the *Jews* muſt know before they can comprehend it? in my mind the leſs they knew of thoſe things, the fitter they would be to underſtand the Theory; at leaſt, I am ſure they would be more eaſily perſwaded to believe it. We ſee now that this way of reaſoning as the *Theoriſt* has apply'd it, is of no force againſt the *Moſaick Hiſtory*, for his refin'd Theory if it had been true, might have been as eaſily comprehended by the *Jews*, as the plain and ſimple *Coſmogonia* of *Moſes*.

The *Theoriſt* perhaps may think, that I have here and elſewhere treated his Theory with too much contempt and diſdain; but let him conſider how meanly he himſelf has ſpoke of ſome of *Moſes*'s writings, with how much ſcorn and deriſion he has rejected his Hiſtory of the Creation; let him think how plainly and openly he has ridicul'd the ſtate of Innocence and the Fall of Man; let him compare what he has ſaid in the *7th 8th* and *9th* Chapters of his *Archæologiæ*, Lib. II. with the hardeſt Expreſſions in this diſcourſe againſt his Theory, and I am confident he will find no reaſon to complain of uncivil uſage.

His *Defender* 'tis true, accuſes me of hard words and coarſe language, in ſaying *that's falſe, that's abſurd, that's ridiculous*; whereas moſt of the Philoſophers have been forced to uſe the ſame expreſſions, inſomuch that they became Philoſophical terms, and (till the *Defender* began to write ſo ſmoothly) Men were never accounted rude and uncivil for uſing of them. Nay, the *Theoriſt* himſelf has been ſometimes pleaſed to deliver himſelf in the ſame manner, and I am ſure that he has handled the writings of ſome excellent Men with more ſeverity, than his Theory has met with from me.

His rude treatment of *Ariſtotle* may be a ſufficient teſtimony of this, whoſe Philoſophy he never mentions but with the greateſt contempt and ſcorn: Tho' the works of this Philoſopher have been honoured with the general commendations of all the Learned thro' ſo many Ages, and are juſtly ſtill valued by thoſe who have the greateſt reputation either for Polite or Philoſophical Learning; His diſcourſes upon Rhetorick, Poeſy, and Politicks, his Logick and Ethicks, are deſervedly admired as Maſter-pieces in their ſeveral ways; and tho' his Phyſiology is not without errors, yet I am ſure that there is more true Natural Philoſophy in his Mechanical queſtions alone, than in all the Theory. But if ſome ſort of Philoſophers are not acquainted with the true value of this Author, yet the general reception that he has found in all the Univerſities of the Chriſtian World, might one would think, have ſecured him from the rude inſults of any private Writer.

However, the *Theoriſt* is not ſatisfy'd with expoſing this great Man and his Philoſophy as they come in his way, but in order, as he thinks to make him more contemptible, has given us a ſhort View or Catalogue of his errors, If I ſhould do ſo with him, and ſet down a Collection of all the errors that may be found in his writings, they would I am afraid, tire the Readers patience, and make a Folio almoſt as big as the Theory.

At laſt, he takes his leave of *Ariſtotle* in thoſe very civil terms, *Vale Stagyrita, ſemper mihi eris malus Aſtronomus, Theologus pejor, Phyſiologus peſſimus.*

It were eaſy for me if I deſign'd to be ill natur'd, to change the word *Stagyrita* into *Theoriſta*, and then take my leave in the very ſame form: but tho' I think the *Theoriſt* far inferior to *Ariſtotle*, yet I am not for parting with him in ſo rude a manner; I acknowledge him to be an ingenious Writer, and if he had taken a right method and had made a conſiderable progreſs in thoſe Sciences, that are Introductory to the ſtudy of nature, I doubt not but that he would have made a very acute Philoſopher.

It was his unhappineſs to begin at firſt with the *Carteſian* Philoſophy, and not having a ſufficient ſtock of Geometrical and Mechanical principles to examine it rightly, he too raſhly believed it, and thought that there was but little skill required in thoſe Sciences to become a Philoſopher, and therefore in imitation of Monſ. *Des Cartes*, he would undertake to ſhew how the World was made, a task too great even for a Mathematician.

All that I now deſire of him, is to ſpend ſome time in the ſtudy of Numbers and Magnitude, Aſtronomy and Staticks, that he may be the better able to underſtand the force of my Arguments againſt his Theory, after which I doubt not but that he will eaſily perceive its errors, and have the ingenuity to acknowledge them. But till then, all further diſputation between him and me, muſt needs be vain and frivolous, ſince true reaſoning in Natural Philoſophy depends on ſuch Principles as are demonſtrated in thoſe Sciences, the knowledge of which he has not yet attained.

A
DEFENCE
OF THE
REMARKS
MADE ON
Mr. Whiſton's *New Theory.*

IN my Anſwer to the two *Theoriſts*, I endeavoured to ſhew, that neither of them had lit upon an Hypotheſis which would ſolve the *Phænomena* of the Creation and the Deluge, according to the Moſaick Hiſtory; and that the ſchemes they had drawn, might be confuted by their own principles: I thought, all that could be expected from me was, to ſhew, that both of 'em were unlucky in the choice of their main Hypotheſes, and unskilful in the management of them.

But Mr. *Whiſton* in the firſt Paragraph of his Vindication, has ſurpriz'd me with a new diſtinction between an *Hypotheſis* and a *Theory*, and tells me, That in a Theory, (ſuch as he deſires his ſhould be thought) *Wit and Skill are qualifications not neceſſary, and very little to be conſidered therein.* If this be allowed, all Theories are unanſwerable: But upon preſumption that every body is not of his opinion, I ſhall perſiſt in making good my firſt Objections againſt him.

As to the account he gives of the Origin and Progreſs of his Work, the Perſons and opportunities that were conducing to it, I can only ſay, it ſhews too great a fondneſs for his Theory; and 'twas ſcarce worth his while to trouble his Reader with ſuch minute relations about it, eſpecially after it was, as I preſume, already confuted. But however, ſince I have read this Hiſtory of its Birth, I am leſs ſurpriz'd at the miſtakes I meet with in it; ſince that *very Learned Friend* of his, upon whoſe judgment he ſeems chiefly to rely, (for I dare venture to ſay Mr. *Newton* wont engage for the truth of all his Theorems) has given the World reaſon enough to ſuſpect him, none of the ſhrewdeſt Judges of that part of Learning.

After Mr. *Wh.* has duely inform'd his Reader, by what ſteps and methods he accompliſh'd his wonderful performance, he tells us, That *it is a little ſurpriſing*, that *I of all Men ſhould in publick appear againſt him.* His Reader may think, by this way of ſpeaking,

ing, that there lay ſome ſpecial Obligations on me to be ſilent, tho' I declare I know none; I never enjoy'd the happineſs of Mr. *Whiſton*'s acquaintance, and therefore cannot gueſs, what it is that ſhould oblige me more than any other, to forbear publiſhing Remarks on his Theory. 'Tis true, I did and always ſhall reſpect and honour him, as a Learned and Ingenious Man; but I hope he does not think, that upon this account I ought to have ſuppreſſed all Objections againſt his Philoſophy. He ſeems to be of opinion, that it was my duty, privately to have communicated my difficulties to him by a Letter, and not to have taken this publick method of writing Remarks on the *New Theory*. I declare, I am altogether inſenſible of ſuch a duty, and I don't think, that I have tranſgreſſed the rules of civility by what I have done. It is commonly thought, that whatever any one publiſhes is ſubmitted to the judgment of its Readers, and any one of them may take the ſame liberty in publiſhing Remarks upon it, that its Author did at firſt in propoſing it to the World: And ſince I am perſwaded that my Objections againſt the *New Theory*, are at leaſt, as ſtrong and convincing as his Reaſons are for it, I cannot ſee, why out of a complement to Mr. *Whiſton*, I ſhould ſuppreſs them.

Mr. *Whiſton* ſays, that I am deeply engag'd againſt his deſign, thro' a peculiar fondneſs I ſeem to have for unaccountable Miracles. If I had a mind to criticiſe upon words, I would ask him what he means by unaccountable Miracles, and whether there be any that can be accounted for, ſince it is the common opinion, that what can be accounted for by natural cauſes, is no Miracle. However, I know no Miracles I am fond of, ſave thoſe mention'd in Scripture; and at preſent I am only engag'd in the Defence of two of them, *viz.* The Creation and the Deluge, and a fondneſs for them ſeems not to be peculiar to me; ſince till this Age of World-makers, Chriſtians have always thought them ſuch works, as could never be produced by the Laws of Nature and Mechaniſm.

I know indeed that there are ſome, who are not only for explaining the above mentioned, but even moſt of the other extraordinary events recorded in the holy Scripture, by natural principles: But I dare ſuppoſe Mr. *Whiſton* would not willingly be put into a Catalogue with ſuch Authors. I could, and I think with juſt Reaſon too, tell him, that if he had not a peculiar fondneſs for his own Theory, he would eaſily perceive, that all thoſe things which he endeavours to deduce from Mechanical principles, are not to be explain'd by ſuch cauſes. But I am willing to paſs by his preliminaries, and enter upon his argument.

I firſt objected againſt the *New Theory*, that the Chaos, which was the origination of our Earth, could not have been the Atmoſphere of a Comet, ſince the one is repreſented as a dark caliginous Body, having darkneſs on the face of its Abyſs, and the other was a tranſparent fluid, and was enlightned, if not from its own Central Body from within, yet at leaſt by the Sun from without. To this he Anſwers, that Comets cannot be changed into Planets till their return from the vaſt and cold Regions beyond *Saturn*; and he ſays, that we need not think that they will be then ſo vehemently hot, that they muſt be light alſo. If what he ſays in another place is true, I cannot but ſtill think, that they muſt be hot to ſuch a degree, that they will alſo be extreamly Luminous; for according to him, the heat is ſo great even after their return towards the Sun, that all the parts of their Atmoſpheres are in a violent agitation, heavy and light, denſe and rare, fluid and ſolid parts, are jumbled and mixed together in the greateſt confuſion, thro' the violence of the heat. This I think, is ſufficient to make us believe them very lucid likewiſe. But ſays he, ſolids preſerve ſome of their heat after their light is gone. But is it credible, that the heat of the Central ſolid ſhould be ſo great as to preſerve its Atmoſphere, at the diſtance of ſome hundred thouſands of miles, in a continual agitation, and at the ſame time not be light? Can we ſuppoſe that it will raiſe vapours into its tail to the diſtance of many millions of miles, and after all imagine, that it is not ſo hot as to be lucid? This I think would be as great a paradox, as any that is to be met with among the Philoſophers.

It's known, that the intenſeneſs of light and heat is always proportional to the denſity of Rays that produce them, and that this denſity, is in all places in a reciprocal proportion to the ſquares of the diſtance of the Body, from which they proceed; and by conſequence it is plain, that heat and light muſt be prodigiouſly ſtronger at or near the ſurface of the hot or lucid Body, than at a great diſtance from it; and therefore it is no wonder, if the heat of a ſolid be very ſenſible to a hand that is laid upon its ſurface; when the Eye placed at a diſtance from it, cannot perceive its light. But let us bring this point into numbers, that we may ſee it more evidently. It follows from Mr. *Whiſton*'s own poſitions, that the heat of the Central ſolid muſt be ſo great, even before the Comet arrives at its *Perihelion*, as to act upon the Atmoſphere at the diſtance of 10000 miles, and from thence to raiſe vapours into its tail for many millions more; and therefore the intenſeneſs of its heat at that diſtance, muſt be to the intenſeneſs of the heat at the diſtance of ten miles, for example, as the ſquare of ten is to the ſquare of 100000 miles, that is, as one to 100000000. If therefore the heat of the Central ſolid at the diſtance of 100000 miles had any ſenſible effect upon its Atmoſphere, it muſt be prodigiouſly ſtronger at the diſtance of ten miles, and therefore cannot be ſuppoſed to be without light.

He allows the Sun to ſhine thro' the Atmoſphere of the Comet, whilſt it remains ſuch; But then upon the Commencement of the Creation, when it began to move in a Circular Orbit, it loſt its pellucidneſs, and became a dark and opake fluid. How this ſhould come to be I know not, nor can I diſcover, why upon the change of the Comet's Orbit from an Ellipſis to a Circle, its Atmoſphere ſhould be likewiſe changed on a ſudden from a clear and tranſparent fluid, to a dark caliginous one. Immediately before the change of the Orbit, even after it had deſcended from the cold Regions beyond *Saturn*, he allows its Atmoſphere to have been ſo bright and diaphanous, as that the Central ſolid might have been ſeen thro' it. It muſt be then a miracle and an unaccountable one too, that could have cauſed ſuch an immediate darkneſs. It was alſo objected to him, that his denſe and heavy fluid, could not be the Moſaical Abyſs; for it was at firſt dark, and afterwards enlightned, whereas his new Abyſs after it was once dark, never again became

came viſible, being always covered with an opake Cruſt. Here he owns, that the word Abyſs is not to be reſtrained to his denſe fluid, but that it comprehends all that heterogeneous and hitherto muddy fluid, which was beneath the Earths future ſurface, where the Spectator in the Hiſtorical Journal of the Creation, is ſuppos'd to have been.

But I deſire him to tell us, whether this muddy fluid was afterwards enlightned; whether the ſame collection of Opake and Earthy Corpuſcles which produced a darkneſs on the ſurface of the denſe and heavy fluid, would not create alſo a thick darkneſs upon the ſurface of the muddy one; whether this darkneſs would not continually encreaſe, as thoſe Earthy and Opake particles came cloſer together, and when at laſt they fell upon, and encloſed this muddy fluid, and form'd a Cruſt (according to him) of 60 or 70 Miles depth, whether they would not exclude the light from it for ever.

I had urg'd to him, that 'twas ſaid in Scripture, *Darkneſs was upon the face* or the exterior ſurface *of the Abyſs*, and that afterwards there was light upon it. Now if Mr. *Whiſton* cannot ſhew us clearly an Abyſs from his principles, whoſe exterior ſurface was firſt dark, and afterwards luminous, I hope he will grant that his Theory is not conform'd to the Moſaick Hiſtory.

Another Argument againſt the Theory, was to this purpoſe. If the Earth was form'd by the principles of Mechaniſm out of the Atmoſphere of a Comet, we muſt allow the whole ſubſidence to be as leiſurely, and to proceed by the ſame ſteps that the violence of its heat decreaſes, which would not then (as he would have it) be compleated in ſix Years, nor indeed in as many Centuries; and the Opake parts would take ſo much time in deſcending and compoſing the Cruſt of the Earth, that the Sun would always illuminate (at leaſt the upper Regions of its Atmoſphere) as freely as it does the whole Atmoſphere of Comets, while they are within our Obſervation. He allows this to be an Argument of good force, and to deſerve conſideration; and he tells us, that if Comets were obſerv'd to have no Atmoſphere after their return from the Regions beyond *Saturn*, before they arrive at their *Perihelia* again, then indeed this reaſoning were unavoidable; but ſeeing the contrary is evident from Aſtronomical Obſervations, it cannot affect his Hypotheſis. If he had deny'd any Propoſition in my Argument, or any conſequence drawn from it, I ſhould have known what reply to have made; but I cannot apprehend how this Obſervation upon Comets does in the leaſt affect my Argument, nor imagine to what purpoſe it was brought in here, but to amuſe ſome thoughtleſs Reader.

He tells us farther, that the Laws, Properties, and Operations of Bodies, which we find eſtabliſhed here on Earth, do not univerſally obtain in the Atmoſpheres of Comets. This I own to be an Anſwer, not only to this one Argument, but to all that can be ſaid againſt his Theory. But may not any other Theory be defended at the ſame rate? Might not Dr. *Burnet* have maintained his Theory this way? And when it was objected againſt it, that heavy Bodies, ſuch as Earth, Clay and Stones, could not ſwim upon Oil or Water, would it not have been eaſy for him to have ſaid, that Bodies had then other Laws, Properties, and Operations, than they have now, and that it was at that time the Law of Nature, that the heavieſt Bodies ſhould ſwim uppermoſt, and the lighteſt fall to the bottom? Tho' one would think, that it were as impoſſible that there ſhould be ſuch a Law of motion, as that a Propoſition in *Euclid* ſhould be falſe. If the Laws of motion were arbitrary and changeable, why ſhould the Mathematicians pretend to demonſtrate them as neceſſary conſequences from their principles? Let us ſuppoſe a *Vectis* in one of Mr. *Whiſton*'s Comets, and two powers apply'd to its *Brachia*, upon which they act perpendicularly, ſo that the powers be to one another in a proportion reciprocal to the length of their *Brachia*. It is actually impoſſible but theſe two powers muſt act equally, the one againſt the other, or that one of them unaſſiſted by any other cauſe, ſhould be able to move the other againſt its direction: Since effects muſt be always proportional to their adequate cauſes. And yet, according to Mr. *Whiſton*'s poſition, this Law of Nature perhaps is only true in our Earth, and not in any Planet or Comet whatſoever.

By this Anſwer Mr. *Whiſton* has granted me all that I deſigned to prove, *viz.* That the Earth was not form'd according to the known Laws of Mechaniſm, but by the efficacy of the Divine Spirit which mov'd upon the face of the Waters.

It was ſaid in the Remarks, that there is no need of a hot Central ſolid, to ſolve the origin of Springs, and ſuch other *Phænomena* of nature; they being better accounted for by other means. To this it is anſwered, that the reality of an internal heat within the bowels of the Earth, is a matter of fact, and muſt be accounted for whatever becomes of Springs. I always allowed an internal heat, but thought it might be accounted for without a hot internal ſolid; and I refer him to what has been ſaid upon this ſubject, in the Examination of the Reflections on the Theory.

Mr. *Whiſton* thinks, that the account I refer to for the origination of Fountains is not ſo univerſal, as to ſtand in no need of ſubterraneous vapours; But ſince he has given us no reaſon for this thought of his, I need ſay no more to it, but that I think otherwiſe; I am ſure it is evident by Calculation, that the Vapours raiſed by the heat of the Sun from the Sea, are alone ſufficient to ſerve all our Rivers and Fountains with Water. And nature never makes uſe of two diſtinct cauſes where one would do; for then the effect would be greater than it ought to be.

I told him, that he receded without neceſſity from the literal ſenſe, in ſuppoſing, that the formation of the Sun, Moon and Stars, mention'd in the firſt of *Geneſis*, is to be only underſtood of their being made viſible, and of their appearing to an eye placed in the Earth. But ſince he deſires to know my reaſons for this opinion, I muſt tell him, that his interpretation ſeems to be extreamly forced, and no way agreeable with the deſign of the ſacred Pen-men. *Moſes*'s narration is plain and ſimple, and throughout the whole, he does not affect to ſpeak either Metaphorically or Allegorically; but he delivers it as certain matter of fact, which we are firmly to believe. He plainly mentions the Creation of the Sun, Moon and Stars, and makes the production of them a diſtinct days work by its ſelf; In expreſſing their formation, the ſame word ויעש *(and he made)* is uſed, that is found afterwards in the 25th verſe, where there is an account given of the production of beaſts; and therefore *Moſes* ſeems to have deſign'd ſign'd that the word ſhould be taken in both places in the ſame ſenſe. Beſides all this, it is certain, that *Moſes* did not ſpeak of things as they appeared, or would have appeared to an Eye placed in a muddy fluid, ſince there was no one then in being to whom they could have appeared.

From all theſe conſiderations, I think it evident, that it was *Moſes*'s intention to be underſtood in a real and literal meaning. I deſire Mr. *Whiſton* to conſider what is ſaid more at large upon this ſubject in the Examination of the Reflections on the Theory.

But after all, I do not ſee that Mr. *Whiſton*'s reaſons prove any impoſſibility in *Moſes*'s account of the Creation; all that I think he proves in his long diſcourſe is, that the plain and ſimple account that *Moſes* gives us, is not agreeable to his Theory, to his way of thinking, or to the method by which he would have the World produced.

His Theory ſuppoſes, that the Sun upon the ſecond day before it became viſible, raiſed as many Vapours from the Earth, as were ſufficient to fill all the Seas, Lakes, and Rivers that were in the Primitive Earth. Here, I thought he aſſign'd a cauſe no ways proportional to the effect. For ſince the Sun even when it ſhines very ſtrongly and directly upon our Ocean, does in a whole year raiſe but the thouſandth part of our preſent Ocean into Vapour, how can it be ſuppoſed, that it could raiſe as much

Vapour in that time, as would fill the Seas, Lakes, and Rivers, of our Primitive Earth, when all the while it was not viſible, but obſcured by a dark and thick Atmoſphere, by which the power of its beams muſt be extreamly weakned. In anſwer to this, he tells us, That he does not ſuppoſe that all the Water that was in the Seas, Lakes and Rivers, of the firſt Earth, made above the thouſandth part of our preſent Ocean, which he thinks might have been eaſily exhaled by the Sun in one half year.

Vindic. pag. 9.

Now I would have him to conſider this Objection a little further, and he will find that it is not ſo light as he imagines it is: he knows that there muſt be a certain proportion betwixt Land and Sea, that the ground may be ſufficiently furniſhed with rains and dews: for the quantity of Vapour that is raiſed from Water, all other things being alike, is always in proportion to the ſurface of the Water, and if the ſurface of our Sea were, *for example*, but the thouſandth part of what it is now, there would in that caſe be raiſed but the thouſandth part of the Vapour from it, that is at preſent raiſed from thence; and becauſe the dry Land by ſuch a ſuppoſition would be near double of what it is now, it follows from thence, that any particular piece of ground would not have much above one part of two thouſand of the rains and dews it has at preſent. So that if this had been the caſe of the Primitive Earth, it muſt have been abſolutely barren and unfruitful: But if that cannot be allow'd, it is evident, that there muſt have been a much greater Sea there to make it habitable, than what Mr. *Whiſton* ſuppoſes.

But if after all the Antediluvian Sea had been form'd only by the raiſing of Vapours by the Suns heat for one half year, I do not ſee how it could have amounted to the ten thouſandth part of our preſent Ocean. For it is known, that a few Clouds will more obſcure the light of the Sun, and by conſequence diminiſh its heat in the ſame proportion, than if nine in ten parts of its Disk were obſcur'd by an Eclipſe: however, I will only ſuppoſe, that its heat was but juſt as much diminiſhed by the thick Atmoſphere Mr. *Whiſton* ſpeaks of, (which had perfectly darkned and obſcured his body for more than two years) as it would be in an Eclipſe, where nine ten parts of its Disk were obſcur'd; and then the number of Rays producing heat in any part, being but a tenth part of what they are now upon us, they would not raiſe above a tenth part of the Vapour that could be raiſed by the free and open action of the Sun. But the Sun when it now acts upon us freely, raiſes not much above one thouſandth part of the preſent Ocean into Vapours; therefore it is evident, that in the other caſe it could not raiſe much above the ten thouſandth part of the preſent Ocean, and a Sea only formed from thoſe Vapours, would be little better than none at all.

But allowing it poſſible in the manner Mr. *Whiſton* contends for, allowing him too, that this ſmall ſtock of Waters was ſufficient for the neceſſities of the Earth; yet after all this way of forming the Primitive Sea is by no means agreeable to the account given us by Moſes, *Where we are told, that God divided the waters which were under the Firmament from the waters which were above the Firmament, and the waters under the heavens be gathered together into one place, and the gathering together of the waters called he Seas.* But Mr. *Whiſton* tells us, the Sea was made by thoſe Waters that were raiſed into Vapour by the heat of the Sun, that is according to his interpretation, by the Waters above the Firmament, which is directly contrary to *Moſes*'s account, who ſays, it was made by the gathering together of the Waters under the Firmament. It muſt be ſtrange turning and wreſting of words, that will bring both theſe ways to agree.

Beſides, if the Sea were formed as the *New Theory* ſays it was, the dry Land muſt have appeared immediately upon the raiſing of the Vapours, whereas, according to *Moſes*, it did not appear till after the formation of the Sea. It is plain then, that this Theory of the Sea given us by Mr. *Whiſton*, is in every circumſtance as inconſiſtent with the holy Hiſtory, as 'tis with Reaſon and Philoſophy.

Mr. *Whiſton* acknowledges, that my reaſoning againſt his third Hypotheſis of an only annual motion of the Earth before the Fall, is ſtrong and forcible, and therefore he has been pleaſed here to invent another Hypotheſis to ſupport the former, by which he hopes to remove all the difficulties that were raiſed againſt it; *viz.* That the Earth did not revolve in a Circular Orbit till after the Fall, but in a *moderate Ellipſe.* I ſhall not trouble my ſelf with new anſwers as often as he thinks fit to contrive new Hypotheſes, and therefore will only give this reply at preſent, that it will ſcarcely be allowed, that but one half of the Primitive Earth was habitable before the Fall, as it muſt be by ſuch a ſuppoſition. We know, the more Hypotheſes any Theory is clogg'd with, the more precarious it looks; ſuch of them eſpecially as do not naturally reſult from the whole Theory, but are only introduced to remove ſome urgent difficulty, are generally thought leaſt of all to deſerve any credit. One of the great Beauties of the Theory was, That aſſoon as the Comet was turned into a Planet, it had a Circle for its Orbit, and tho' this beauty is not perfectly ſpoiled, yet its luſtre ſeems to be conſiderably diminiſhed by the new ſuppoſition of his new ſort of Figure call'd a moderate Ellipſe.

Mr. *Whiſton* is pleaſed to take notice of a ſuppoſed miſtake, he imagines I have committed, about the quantity of heat in the Primitive Earth, which I reckoned from his principles, muſt have been ſome hundreds of times greater than what is in the preſent. This he ſays, *he is ſure is a plain error*, who ever it was that made him ſo ſure of it, I am certain they have mightily deceived him. If he had taken the pains to conſider, that the heat of the Sun for any ſmall portion of time is always as a Rectangle, contained betwixt the Sine of the Angle of incidence of the Ray producing heat, and that time, and had troubled himſelf a little further to calculate the proportion of the quantity of heat that was in the Primitive Earth upon his Hypotheſis, to that which is in our preſent Earth, he would have found the miſtake was not on my ſide by his own. Every body knows, that the longer any thing is expoſed to the heat of the Sun, the hotter it muſt be; and this is ſo manifeſt, that a great part of our heat in the Summer ariſes only thro' the length of time the Sun ſhines upon us. For if our Summer and Winter days were each of them twelve hours long, the heat in Summer would be to that in Winter, in proportion little more than three to one, (their difference in that caſe ariſing only from the more direct action of the Sun in Summer than in Winter) whereas, in the preſent caſe, our Summers heat is to our Winters heat in a greater proportion than that of ſeven to one.

It was objected againſt the *New Theory*, that a Comet coming near the Earth could not produce any tide in the Abyſs below the Water, becauſe it was cloſely ſhut up by a thick and ſolid Cruſt, that preſſed ſo cloſe upon it as to leave no ſpace, at leaſt, not ſuch a conſiderable one, as would make room for any conſiderable commotion of the Waters. In anſwer to this, he tells us, That he wonders how I come to imagine the Orb of Earth to be ſo compact and ſolid a Sphere, as to be able to overcome the great impulſe the Abyſs would make upon it, at the approach of the Comet. We may eaſily conceive this to be no Argument, if we conſider, that a tide is nothing elſe but a great agitation or commotion of the Waters, ariſing from the attraction of ſome great body placed near it; and becauſe the velocity of the Waters produced by this attraction, is at firſt infinitely ſmall, their force upon any other body muſt likewiſe be infinitely ſmall in compariſon of what it will be after the Waters have acquir'd a certain determinate velocity. For as in a heavy body its velocity or force by which it endeavours to deſcend, is at firſt infinitely ſmall in proportion to that which it acquires in any determinate time; ſo here, if we ſuppoſe the velocity impreſſed on the fluid by the attracting body to be always in proportion to the time, and at the end of any determinate time [*Fig.* 20. *Plate* X.] A B in which it has moved, it has acquired the velocity B C: After the firſt inſtant of time A *d*, its velocity was as *d e*; and becauſe A B is infinitely greater than A *d*, it is plain from thence, that B C muſt be infinitely greater than *d e*, that is, the force or impreſſed motion upon the fluid after it has moved in the time A B is infinitely ſtronger than it was in the beginning of its motion.

Let us now apply this to the caſe in hand; and in the preſent Figure [*Fig.* 21. *Plate* X.] let C repreſent the Central ſolid, A B D K the denſe Abyſs, F G H E the outward Cruſt lying cloſe upon it, and partly ſubſiding in it. This Cruſt Mr. *Whiſton* imagines to be 200 miles in depth. If the Abyſs had acquired any impulſe or velocity by motion, and by that force acted againſt the Cruſt, I make no queſtion but it would be able to break it and crack it into as many pieces as Mr. *Whiſton* pleaſes. But here there is no room left for motion, no vacuities, or void ſpaces: wherever the fluid is attracted, its motion will be abſolutely reſiſted, either by the fluid next, or a denſe and ſolid Cruſt immediately contiguous to it. The ſmall cracks and fiſſures Mr. *Whiſton* mentions, would be abſolutely incon-

Fig. 20.

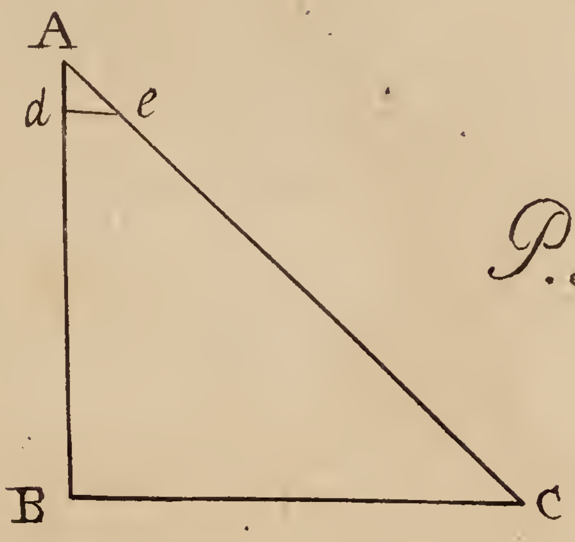

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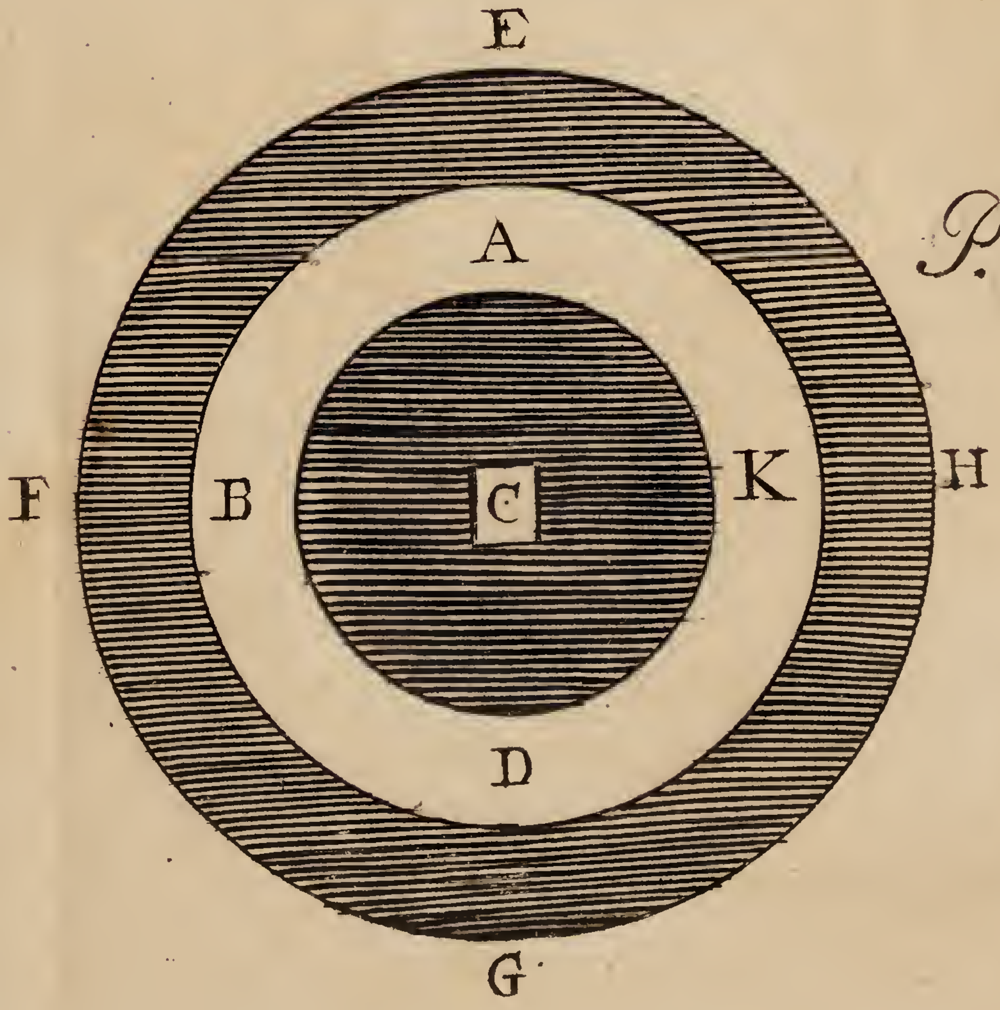
Fig. 21.



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inconſiderable, and the motion in them could not be ſtrong enough to break or disjoyn ſo thick a Cruſt, whoſe parts by their own weight, and their cloſe ſubſiding together, would be firmly compacted and united. Whatever the cracks and fiſſures were, which he imagines at firſt made by the Diurnal Rotation of the Earth, in the ſpace of 1660 years, they would come to be healed and made up, ſo that there would not be ſo much as one ſubſiding column that can be ſuppoſed ſeparate and disjoyn'd from the reſt. And tho' we may ſtill ſuppoſe ſome ſmall fiſſures in the Earth, yet he aſſerts that they were moſt in the Mountains; and therefore it is impoſſible that the Strata could be disjoyn'd and ſeparated from one another by them.

All the effect that would follow from this attraction is this, Both the fluid on the Abyſs and the Central ſolid would be attracted by the Comet; but the fluid on the Abyſs being nearer to it than the other, would be more ſtrongly attracted; and becauſe the ſolid Cruſt by reaſon of the firmneſs and union of its parts, cannot move faſter to the Comet than the Central ſolid does, it is evident from thence, that it muſt be preſſed only by the difference of attraction, or by that force by which the fluid in the Abyſs is drawn more towards the Comet, than the Central ſolid is; and ſeeing the fluid has acquired no velocity or impetus by motion, it is clear from what is already prov'd, and by what is more fully demonſtrated by *Borell* in his 24 25 and 26 Chapters of his Book *De vi percuſſionis*; that the force of the fluid thus preſſing, will be infinitely leſs than what it would be if it had acquired any determinate degree of velocity by motion. And ſince Mr. *Whiſton* ſeems to acknowledge, that a great impulſe of the fluid would be neceſſarily required to break and disjoyn the Cruſt, the ſmall force ariſing from the preſſure of the fluid, can never be able to produce ſo great an effect.

What Mr. *Whiſton* ſays of *a Floor of disjoyn'd Planks laid croſs the Thames*, that may as well be ſuppos'd to ſtop the Tide or the aſcent of the Waters, as the Cruſt of the Earth the Tide of the Abyſs, is I think no parallel caſe. For it is not the attraction of the Moon that is the immediate cauſe of the Tide in the *Thames*; but it ariſes ſolely from the check and great impulſe that the Waters receive from the motion of the Sea, by which they are driven backwards with violence, and are made to aſcend up the River and produce Tides.

But if Mr. *Whiſton* will ſtill aſſert, that the Strata or ſubſiding Columns were *ſeparated and disjoyn'd like ſo many looſe Planks*, (tho' it contradicts what he has ſaid in another place*) yet granting that it was ſo, I ſhall from thence evidently demonſtrate, that there could no Water ariſe upon that very account from

* *Vindic pag.* 17.

from the Abyſs or Bowels of the Earth, as ſhall be ſhown in its proper place.

The *New Theory* ſuppoſes, that the forty days rain mentioned in the Hiſtory of the Deluge, was cauſed by the vaſt quantity of Vapours that were in the Comet's tail, which being very much rarify'd and expanded, would immediately mount up again into the Air after their fall upon the Earth, and deſcend again in violent and outragious Rains. Againſt this it was objected, that the incredible velocity with which theſe Vapours deſcended, and the great reſiſtance they met with in their deſcent, thro' the Air, together with the force by which they fell upon the ground, muſt of neceſſity have condenſed them into Water. Here he anſwers, that tho' the greateſt part of the Vapours ſhould be condenſed into Rain, yet 'tis hard that I will not allow many of them to eſcape the ſame, enough at leaſt to make a conſtant forty days Rain: for it is ſtrange to him, that ſo thin a Body as our Air, lying in ſo ſmall a compaſs about the Earth, ſhould have the good luck to ſtop and condenſe all and every part of ſo immenſe and ſwift a deſcending Column of Vapours. As ſtrange and hard as it is, yet I cannot ſee how its poſſible any ſhould eſcape being condenſed. If there were any void Canals in our Air thro' which ſome Vapours might deſcend, we might then allow him his Hypotheſis; but ſince it is evident from the nature of our Air, that its impoſſible there ſhould be any ſuch empty ſpaces, it is certain, that there is not one of theſe Vapours but muſt meet with Air, wherever it moves in our Atmoſphere, which it muſt therefore force out of its way; and becauſe it is ſuppoſed to move ſo prodigiouſly ſwift as to deſcend 860 miles in a minute, the reſiſtance it will meet with from every particle of Air muſt be vaſtly great, and muſt therefore neceſſarily condenſe it.

But if I ſhould allow him that theſe Vapours were not condenſed in their deſcent thro' the Air, yet to imagine that they ſhould not be condenſed when they fall with ſo prodigious a ſwiftneſs (as he allows them) upon the Earth, Water, or any other thing that will ſtop their motion, is ſuch a fancy as needs no confutation: if they had ſuch a ſtrange velocity as he ſpeaks of, they muſt penetrate and deſtroy all Humane and other Animal Bodies, ſo that ſuch a ſhower as this one day, would have done the buſineſs of a Deluge, and there would have been no occaſion for other thirty nine days Rain.

But after all this, Mr. *Whiſton* grants, that the Vapours might be condenſed in their fall; but yet he ſays, that their heat which at firſt rarify'd them, and had continu'd their expanſion in the Comets tail, would immediately after their fall rarify them again, and raiſe them into new Vapour. But if ſo, I cannot ſee how this will anſwer the account that *Moſes* gives us of the Deluge, For he tells us, that the encreaſe of the Waters was gradual, and produced in a great meaſure by forty days Rain; and that they continually encreaſed and prevailed upon the Earth for the ſpace of 150 days: whereas by this Theory, the Deluge muſt have hapned all of a ſuddain; according to it, the very firſt day, all the Waters that came from the Comet muſt have fall'n upon the Earth, and by conſequence the Waters that were raiſed from the Abyſs, muſt have immediately aſcended; ſo that if this Theory were true, the Deluge muſt be accompliſhed in one day and not in 150; for as to the Vapours which were raiſed and continued to fall for forty days, (unleſs the water was very ſcalding hot indeed) that would be very inconſiderable, and would rather diminiſh than encreaſe the quantity of Waters upon the Earth, untill they again deſcended in Rain.

I come now to conſider the way Mr. *Whiſton* raiſes the Fluid from the Abyſs. He ſuppoſes, that the great weight of the Water which lay upon the Cruſt, would depreſs it and make it ſink deeper into the Abyſs, and by that means force and ſqueeze the Fluid thro' the fiſſures and cracks of the Earth. But againſt this I poſitively demonſtrated that no preſſure of the Fluid whatſoever, could make the Cruſt ſink deeper into the Abyſs.

In anſwer to this he is pleas'd to tell me, That *my demonſtration ſuppoſes, either that not the water on the Earth but in the Fiſſures, did contribute to the raiſing of the Fluid thro' them, or that the ſeveral Columns had free liberty, and could ſubſide as far as occaſion ſhould be,* (which he has in his Book ſhewed they could not) *or that a preſſure from a Column ſpecifically heavier than the Fluid, is neceſſary to raiſe it upwards.* Becauſe Mr. *Whiſton* anſwers my demonſtration, as if he did not rightly underſtand it; I will here put it into a clearer light and apply it more particularly to the preſent caſe.

Let A B K D [*Fig.* 22. *Plate* XI.] repreſent the Fluid Orb of the Abyſs, E F G H the ſolid Cruſt ſwimming upon it, whoſe parts are ſeparated and disjoined by cracks and fiſſures, *like ſo many looſe Planks laid croſs the Thames,* (and ſo indeed they muſt neceſſarily be, if the Diameter of the Abyſs was enlarged ſixteen miles, as the Theory ſuppoſes) it is certain, that the looſe Cruſt will be ſo far immerſed in the Fluid of the Abyſs, or, which is the ſame thing, the Fluid will riſe ſo far up within the fiſſure, till the ſurface *i k* upon which the Cruſt lyes, is as much preſſed by the weight of the incumbent Column as the ſurface *i h* at the ſame diſtance from the Center, is by the weight of the incumbent fluid; that is, the fluid *m n i h* muſt preſs as much upon the ſurface *i h*, as the ſolid

Plate XI.

Fig. 22.

P. 336.

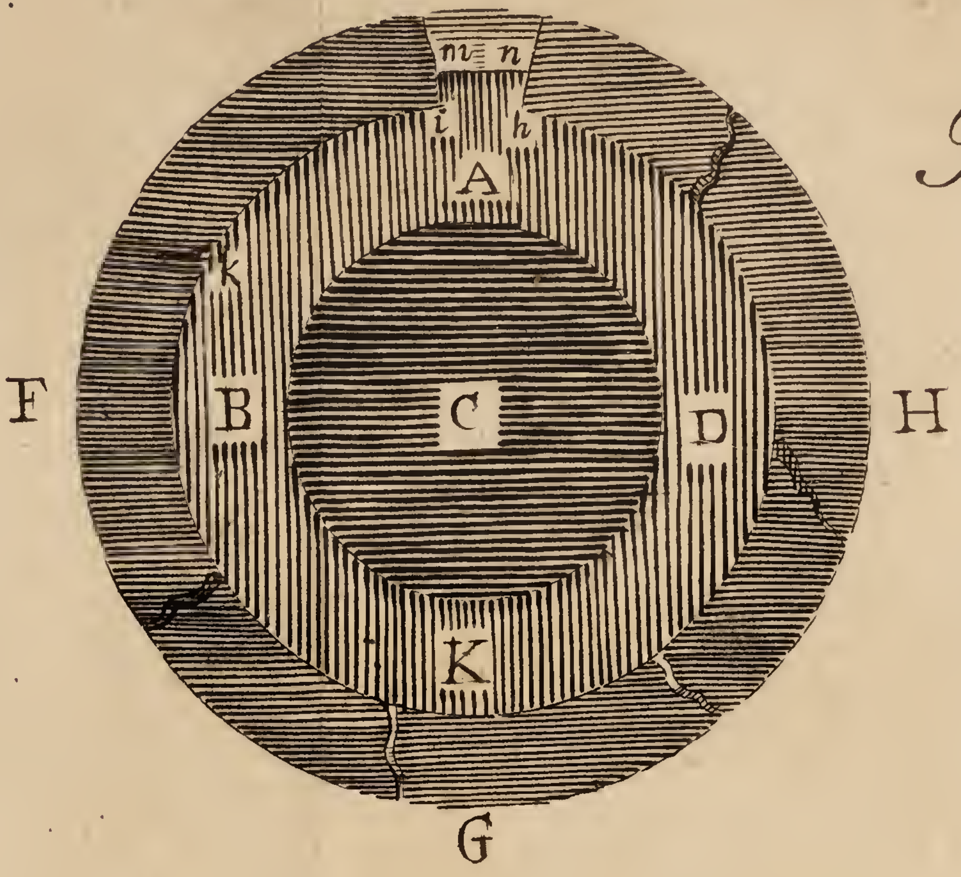
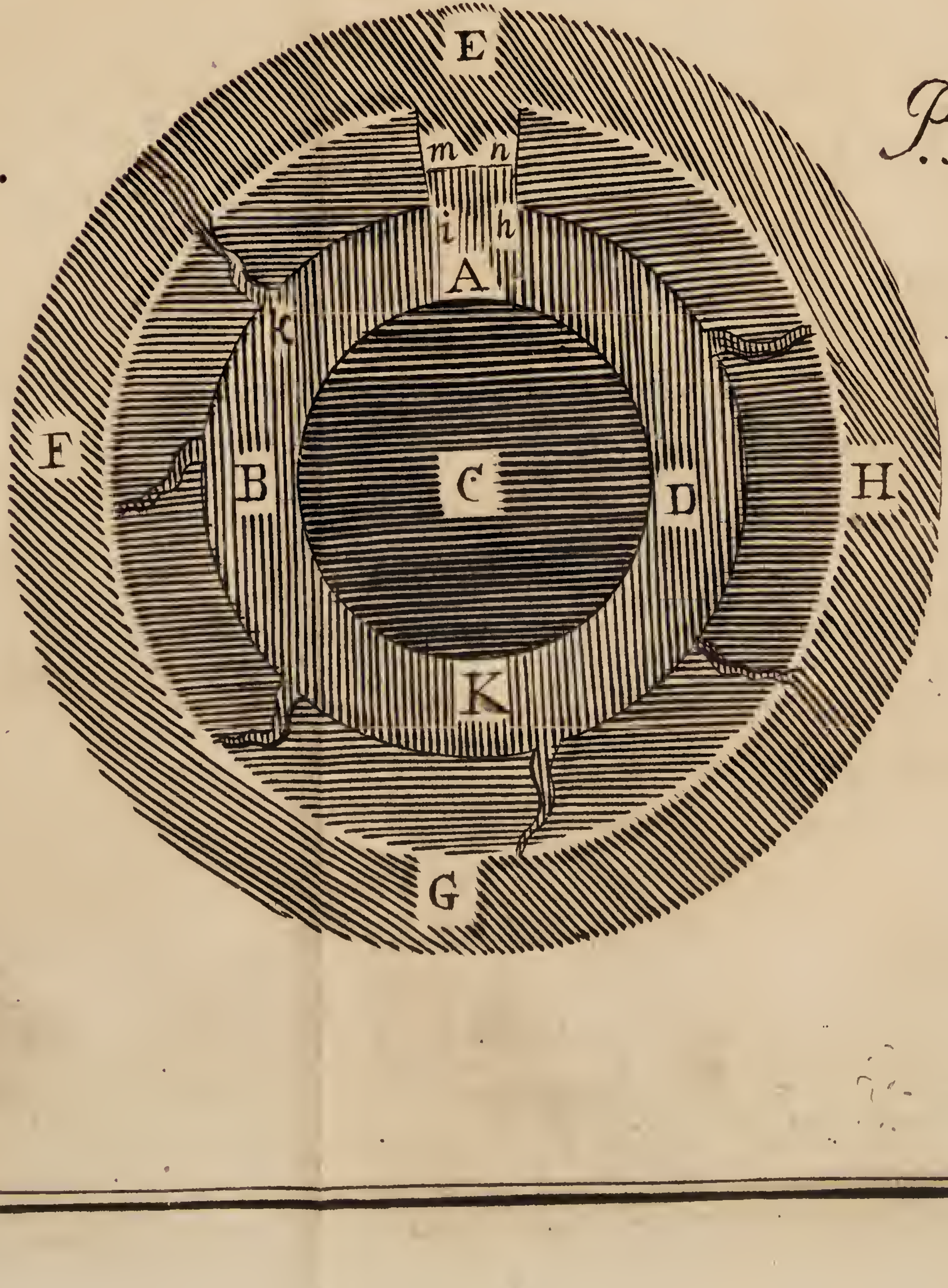


Fig. 23.

P. 337.



lid Cruſt does upon the reſt of the ſurface of the fluid.

Let us next imagine all this Cruſt overflow'd with Water; and becauſe Water cannot lye upon the Cruſt till the fiſſures are firſt entirely filled, the water muſt deſcend thro' them, and preſs upon the ſurface of the Abyſs that lyes within them. Now if the preſſure of the water which lay upon *m n* [*Fig.* 23. *Plate* XI.] the ſurface of the Abyſs within the fiſſure, were exactly equal to the preſſure of the water which lay upon the Cruſt, the ſurfaces *i k* and *i h* being equally preſſed, the parts of the fluid would ſtill remain in the ſame poſition. But here in this caſe the ſurface *i h* in the Abyſs being preſſed with a deeper Column of water than that which preſſes upon the Cruſt, the weight or preſſure of the water upon it, will be greater than the weight or preſſure of the water that lyes upon the Cruſt, and conſequently the ſurface *i h* being more preſſed than the ſurface *i k*, the fluid *m n i h* will deſcend further and raiſe the Cruſt higher, and it will more emerge out of the fluid; ſo that we muſt evidently ſee, that by the addition of this water, the Cruſt inſtead of being depreſſed lower will be raiſed higher.

Mr. *Whiſton* ſays, That *this demonſtration ſuppoſes that the ſeveral Columns of Earth had their free liberty, and could ſubſide as far as occaſion ſhould be, which he has ſhewed in his*

Book they could not. It ſeems then that he owns, that the Columns would not ſubſide if they had their free liberty, but if they had not their free liberty to ſubſide, then he thinks they would ſubſide or ſink deeper into the Abyſs; that is in ſhort, Thoſe Columns would not ſink deeper if there was nothing to hinder them, but if there was any thing that could hinder them from ſinking deeper, then indeed they would, and muſt ſink deeper. This is ſo ſtrange and ſurpriſing a way of reaſoning, that I ſcarcely believe it could have come from Mr. *Whiſton.* It looks much more like the reaſoning of *his learned friend.* I ſhould have thought, that if he had been left to himſelf to argue the caſe, he would have concluded, that becauſe the Cruſt could not ſink deeper when it was left at its liberty, or when there was nothing to hinder it; It would have certainly ſo much the rather not ſunk further, when there was an impediment.

I know but one poſſible caſe where the preſſure of the incumbent fluid can make the Cruſt ſink deeper into the Abyſs, and even in that caſe, I clearly demonſtrated, that the fluid under the Cruſt could not be raiſed ſo high as to ſpread its ſelf upon the ſurface of the Earth. But becauſe Mr. *Whiſton* has not taken any notice of this caſe, nor anſwered any thing to the Calculation that I had from thence deduced, I will here repeat it more clearly. Suppoſe A B C D [*Fig.* 24. *Plate* XII.] a Cylindrical Veſſel half full of water, in which let there be put a wooden Cylinder, which is exactly adapted to the ſides of the Veſſel, ſo that no fluid can deſcend between the ſide of the Veſſel and the Cylinder. It is evident, that if there were no holes in the Cylinder, it could not in this caſe be any ways depreſſed under the ſurface of the water, nor could it ſink into it, if never ſo great an additional weight were lay'd upon it; but the Baſe of the Cylinder would lye immediately on the ſurface of the fluid.

Let us now ſuppoſe this Cylinder bored with holes parallel to its Axis, then indeed it would ſink ſo far within the fluid, till the water within the holes came to be of ſuch a height, as to preſs as ſtrongly upon the fluid under them as the ſolid Cylinder does upon the fluid under it, and there it would reſt at the height, for example, of half the Cylinder, if the water were twice as heavy as the wood. Let us ſuppoſe in the next place, that there were long Tubes fixed in the holes to preſerve the fluid, which is to be poured afterwards above on the Cylinder from running into the holes, and then let Oil or any other fluid lighter then wood, be poured on as high as the very top of the Veſſel; this Oil would indeed preſs upon the Cylinder, and make it ſink deeper into the fluid, which would riſe up within the holes till it preſſed as ſtrongly upon the ſurface of the water under it, as the Oil and Cylinder both together do upon the ſurface of the water under them. Now in this caſe, ſince the water is of a greater intenſive gravity than both the Cylinders of Wood and Oil; it is evident, that it is impoſſible the fluid within the holes can riſe ſo high as the top *m n*, for then the fluid which lyes immediately under that which is conſtain'd within the holes and the Tube, ſuffering a greater preſſure than the reſt of the fluid under the Cylinder, will immediately deſcend and force that which is under the Cylinder to aſcend. So that tho' the ſolid Body muſt in this caſe ſink deeper, yet it is plain, that none of the water within the Veſſel can by this means be brought upon the ſurface.

Let us now apply this to the preſent purpoſe, and ſee what will be the effect. Suppoſe A B K D [*Fig.* 25. *Plate* XII.] a ſolid Mountainous Cruſt laid over the Abyſs; and let the orifices of the fiſſures be ſuppoſed to be only in the Mountains, which we may conceive like ſo many Tubes riſing up from the tops of the Mountains; and afterwards let there be laid upon this Cruſt any load of water whatſoever, F G H for example to the height of two miles.

Mr. *Whiſton* ſays, that it *is evident, that the preſſure of two entire miles over each Column being ſo prodigiouſly great, muſt ſqueeze the fluid upwards*

Plate XII

Fig. 24.

P. 339.

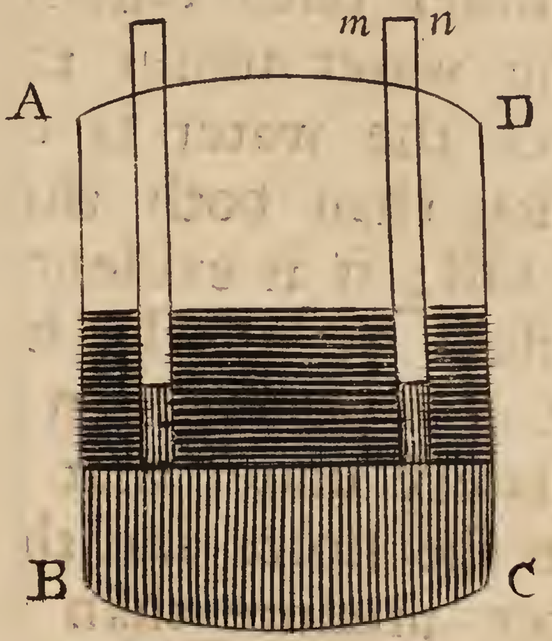
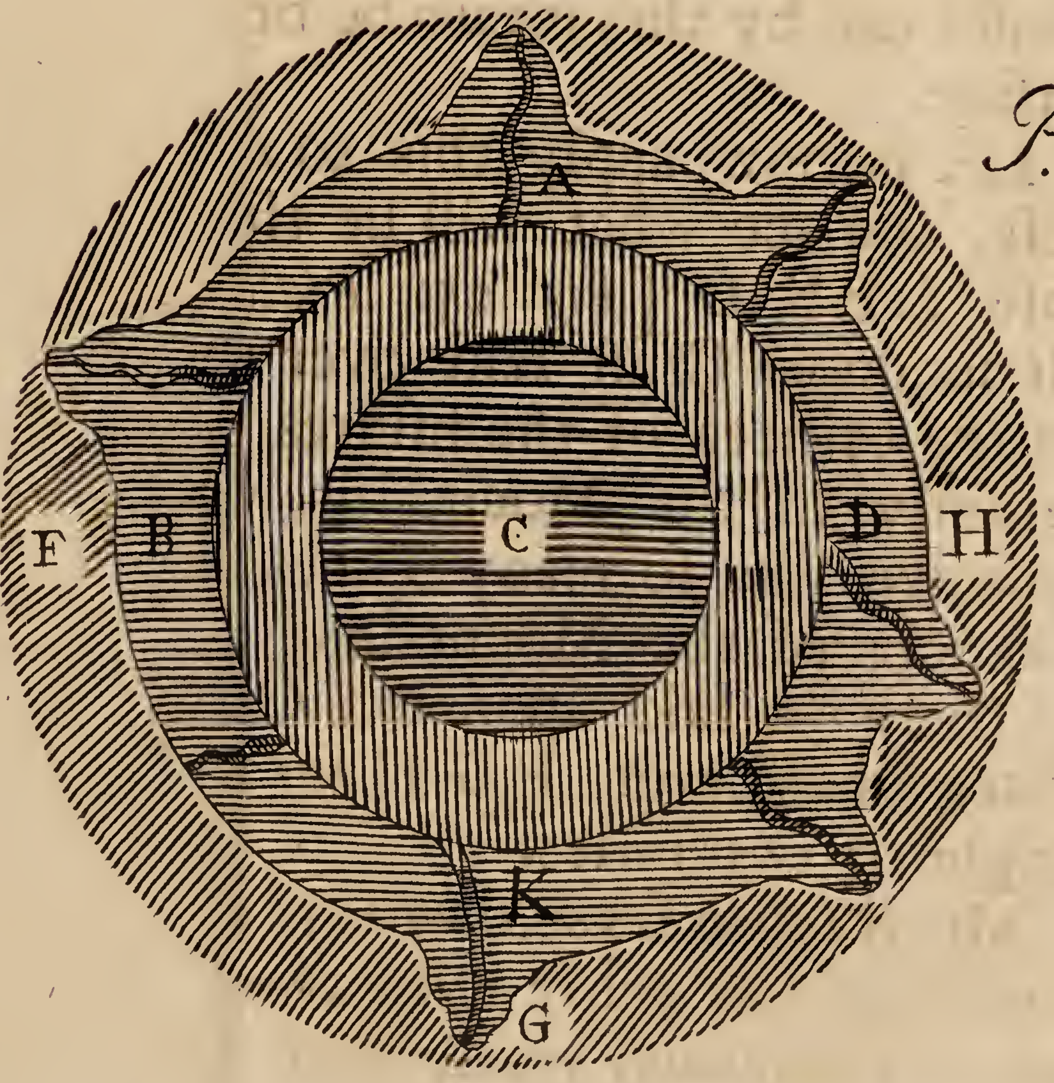


Fig. 25.

P. 340.



upwards thro' the fiſſures, and thereby throw out the incumbent water, and perhaps it ſelf upon the face of the Earth. But as evident as he ſays this matter is, I muſt ſincerely declare, that I cannot ſee how any ſuch effect can follow from a preſſure after this manner. I hope Mr. *Whiſton* does not act here like ſome new Philoſophers, who, when they are to deliver ſome falſe, dark, or incomprehenſible notion, generally uſher it in with a ſpeech about clearneſs and diſtinctneſs, and tell us, That *'tis evident, 'tis plain, 'tis demonſtrative.* But rather than ſuſpect ſuch dealing from him, I could ſuppoſe that the fault was in my own apprehenſion, if I had not demonſtration on my ſide, to ſhew, that from ſuch poſitions no ſuch effect can follow. Does not he ſuppoſe this Cruſt to be compoſed of Columns of 200 miles in depth? Did not they ſubſide cloſe by one another, and form a ſolid Arch upon the Abyſs according to him? If ſo, thoſe fiſſures and cracks upon the Mountains like ſo many windows in a Vault, would not much weaken the ſtrength of the Fabrick; but ſtill it would be able to ſuſtain a much greater weight, Would not the water that came from the Comet immediately ſpread it ſelf equally over the face of the Cruſt? And by this every Column would be equally preſſed, and therefore one could not ſink deeper than another. What is it then that could force the fluid thro' the fiſſures? However, let us ſuppoſe the preſſure much ſtronger upon one place than the reſt; if the ſolid Column upon which this preſſure lay, was cloſely united and cemented to all the other circumambient ones, how could it be broken off from the reſt? It is impoſſible to imagine that the weight of the waters above it could do this. But if it was before ſeparated and disjoyn'd by the Tide on the Abyſs, or any other cauſe, would not the water run down in the fiſſures which ſeparate it from the reſt, and inſtead of depreſſing, elevate the looſe Cruſt, as I have already demonſtrated?

We cannot well ſuppoſe this part which was moſt preſſed, if it was looſe from the reſt, to be ſo cloſely joyn'd to them, as to leave no ſpace for the fluid to deſcend: For it would be a ſtrange chance that would make the ſurfaces of the Columns ſo exactly fitted and adjuſted to each other. Beſides, if they were ſo, becauſe the Arch A B is greater than C D, it is impoſſible that in ſuch a caſe it could deſcend or be forced downwards. But after all, if it could deſcend, I have already demonſtrated, that none of the water in the Abyſs or Bowels of the Earth, could by that preſſure be raiſed ſo high as the tops of the Mountains, that it might from thence ſpread it ſelf upon the ſurface of the Earth.

If Mr. *Whiſton* does not ſee the evidence of this reaſoning, I muſt leave him to be ſatiſfy'd by his own experiment*; only inſtead

* P. 307.

of a Cylinder of Stone or Marble, I deſire him to take one of Wood; and if by pouring Oil upon it, he can raiſe any water from the bottom to the ſurface of the Cylinder, I will give over all reaſoning upon this ſubject; but if he finds that his experiment will not ſucceed, (as it certainly cannot) I hope he will own that he is in an error; and then I doubt not but he will think I had reaſon to ſpeak peremptorily upon this point, when I ſaid that it was demonſtratively evident, that by no ſort of preſſure of the incumbent fluid, the Abyſs could be forced upwards to ſpread it ſelf upon the ſurface of the Earth, which words I do not think fit to retract.

I have already conſidered the ways Mr. *Whiſton* has taken to bring waters upon the Earth, to make a Deluge. Let us next ſee how dextrous he is in removing them. In my Remarks on his *New Theory*, by Calculation I ſhew'd, that there muſt have been at leaſt twenty three Oceans of water, to drown the Earth at the time of the Deluge. One would think that it were a hard task to remove ſuch a load of waters Mechanically. Yet he tells us, that he thinks there is no manner of difficulty in it.

In his Theory he ſuppoſes, that the waters deſcended thro' the perpendicular fiſſures and cracks, which were outlets to ſo great a part of them before; and by that means Saturated all the Pores of the dry Earth, that was capable to contain mighty quantities of water. Now in the Remarks on the *New Theory*, I ſhowed that none of the waters could deſcend thro' the cracks and fiſſures of the Earth; for they of neceſſity muſt have been all full at the time of the Deluge, ſince water cannot lye upon the ſurface of the Earth, till all the cracks, holes, and fiſſures in it, be firſt filled. This is ſo evident both to ſenſe and experience, that it is beyond all contradiction true: it being as impoſſible to make water lye on the Earth before all its cracks, pits, and holes are filled, as it is to make a Veſſel retain water, whoſe bottom is bored thro' with many holes.

Inſtead of anſwering this Argument, Mr. *Whiſton* tells us, That *certainly the Pores and Interſtices of thirty or forty miles of dry Earth, are capable of receiving three or four miles of water into them, and certainly the ſame fiſſures that permitted the aſcent of the fluids from beneath before, would after the ceaſing of that force, permit the deſcent of the waters of the Deluge, and by degrees and length of time draw them off.*

I find Mr. *Whiſton* is generally moſt certain, where other men are moſt doubtful. How can he be certain, or ſo much as ſuppoſe, that the waters could lye above the mouths of the cracks and fiſſures, to the height of two miles perpendicularly, and none of them run in to fill them all the while? What new Laws of Hydroſtaticks has he diſcovered? It is generally ſuppoſed to be the nature of a fluid, to deſcend thro' whatever holes and fiſſures it can find; and 'till they be once fill'd, it is impoſſible it ſhould reſt above the mouths of thoſe fiſſures, eſpecially to the height of two perpendicular miles. For ſo high it muſt have been above moſt of thoſe cracks, ſince moſt part of the Hills in which he ſuppoſes thoſe fiſſures were, do not exceed above a miles height. Before the water could have riſen to ſuch a height, not only the perpendicular holes and fiſſures, but even the Horizontal ones, muſt have been abſolutely filled.

I cannot therefore enough wonder, how he can imagine ſo much water forc'd thro' the Earth upon its ſurface, and all thoſe cracks and fiſſures remaining empty all the time: I am ſurpriz'd to hear him tell us of *dry Earth*, that was capable of receiving vaſt quantities of water, for I cannot ſuppoſe an Earth that has been watered by eleven Oceans of water guſhing thro' its Pores, to be very dry. Another man would rather think, that it muſt have been very wet, for it is not to be imagined, that ſo much water could paſs thro' the Cruſt without leaving as much of it ſelf as the Cruſt could hold behind it, ſince water rather than aſcend will remain in any Pore or empty ſpace that can contain it.

But let us now allow, that the Earth or the Cruſt was as dry as if there had not one drop of water remained in it; yet the Earth thro which water generally can ſink, is but a few feet in depth; the reſt of the Cruſt is compoſed of a *tough Clay*, *common Stone*, *Whinſtone*, *Coal*, *Metalline Ores*, and the like; and I believe he can never perſwade Mankind, that there are ſo many Pores in ſuch heavy, cloſe, ſolid Bodies, as are capable to contain twenty two Oceans of water.

But after all, let us ſuppoſe that the fiſſures were empty, and that they were capable to receive the whole twenty two Oceans of water. Let us ſuppoſe that the water lay over them, without deſcending into them; *that is*, let us grant to Mr. *Whiſton* ſo many impoſſibilities. Yet even all theſe ſuppoſitions will not anſwer the *Phænomena* of the draining of the waters from the Earth after the Deluge. This I think I can prove eaſily, ſince that according to the Moſaical account of the Deluge, the waters were remov'd from off the face of the Earth in one half year; whereas if they had been removed by the method of the *New Theory*, they could not have been drained from the Earth in many hundred years. And therefore upon this account Mr. *Whiſton*'s ſuppoſitions will not anſwer the *Phænomena*. To ſhew this, let us ſuppoſe the mouths of all the cracks and fiſſures to have been juſt equal to the mouths of all the Rivers in the Earth, (tho' if we conſider how narrow and ſmall they are in reſpect of the mouths of the Rivers, we cannot allow them to have been near ſo much) It was proved in the Examination of Dr. *Burnet*'s Theory, that all the waters that run thro' the Rivers would fill the Ocean, if it were empty, in the ſpace of 812 years; and conſequently, if at the time of the Deluge, the water deſcended no faſter thro' the fiſſures, it is evident, that upon the former ſuppoſition it would be 812 years, before the Earth had received one Ocean into its Bowels, therefore it would be 17864 years before twenty two Oceans could be remov'd thro' thoſe fiſſures. But let us now ſuppoſe that the velocity of the water deſcending, was ten times greater than the velocity of the Rivers; we ſhall ſtill find, that the waters would take 1786.4 years to run thro' the fiſſures. So that altho' Mr. *Whiſton* has been pleas'd to ridicule my fondneſs for Miracles, yet ſince all the natural cauſes he has aſſign'd, are ſo vaſtly diſproportionate to the effects produc'd, he may at laſt perhaps be convinc'd, that the eaſieſt, ſafeſt, and indeed the only way is to aſcribe 'em to Miracles.

FINIS.

A
DISSERTATION
ON THE
Different Figures of the Cœleſtial Bodies;

AND FROM THENCE
Some Conjectures concerning the Stars which ſeem to alter their Magnitude; and concerning *Saturn*'s Ring.
With a Summary Expoſition of the *Carteſian* and *Newtonian* Syſtems.

By Monſ. *MAUPERTUIS*.

CHAP. I.
General Conſiderations on the Figure of the Earth.

THE Earth has, from remoteſt Ages, been thought Spherical, notwithſtanding that to common appearance the Surface is exhibited a Plane, and particularly in extenſive Flats or Seas: This Appearance can deceive none but the Vulgar; Philoſophers, of a Mind with Travellers agree the Earth is Spherical. On the one hand, the *Phænomena* ariſing from ſuch a form, and on the other, a kind of Regularity, would not admit the leaſt doubt of this Sphericity; and yet to conſider the Thing with Care, this Notion of the Earth's Sphericity, is ſcarce better founded than the notion that it is flat, from the common appearance which makes it ſeem ſo; for tho' by *Phænomena* we are aſſured the Earth is round, they do not demonſtrate to us that this Rotundity is exactly a Sphere.

In the year 1672, Mr. *Richer* going to *Cayenne*, to make ſome Aſtronomical Obſervations, obſerved that the Pendulum-piece he had carried with him, retarded conſiderably in reſpect of the Sun's mean Motion; whence it was eaſy to conclude that a Pendulum that vibrates ſeconds at *Paris*, ought to be conſiderably ſhortned to vibrate the ſame at *Cayenne*.

If we ſet aſide the Reſiſtance of the Air, (as we may without any ſenſible Error) the Vibrations of a Pendulum that deſcribes Arcs of a Cycloid, or what is the ſame, very ſmall Arcs of a Circle, depends upon two Cauſes; upon the Force wherewith Bodies tend to fall perpendicularly to the Surface of the Earth, and the length of the Pendulum. The length of the Pendulum continuing the ſame, the time of the Vibrations can depend only on the force wherewith Bodies fall, and this time or duration becomes the longer the leſs this Force is.

The length of the Pendulum had not altered in the way between *Paris* and *Cayenne*; for tho' a rod of Metal lengthens with heat, and may acquire an increaſe of extent by being carried to the Equator; this Increaſe is ſuch a trifle that it cannot be ſuppoſed the cauſe of ſuch a Retardation as Mr. *Richer* obſerved, and yet the Vibrations were become ſlower; whence it muſt neceſſarily have been, that the Force whereby Bodies are urged to fall, was become leſs; the weight of one and the ſame Body was then leſs at *Cayenne* than at *Paris*.

This Obſervation was perhaps more extraordinary than any that had been propoſed by this Voyage; it was plainly underſtood to be conformable to the Theory of Centrifugal Forces, and to be what, as we may ſay, ought to have been foreſeen.

A ſecret Force, we call *Weight* or *Gravity*, attracts, urges or impels Bodies towards the Center of the Earth: this Force, if ſuppoſed to be every where the ſame, would make the Earth a perfect Sphere, if it conſiſted of a Fluid and Homogeneous Subſtance, and void of Motion; for it is evident that for each Column of this Fluid, taken from the Center to the Surface, to be in æquilibrio with the reſt, it would be neceſſary for it to be of equal weight with each of the reſt; and Matter being ſuppoſed to be Homogeneous, it would be neceſſary for theſe Columns to be of equal length to make them of equal weight. Now it is in the Sphere only that this Property is to be found; the Earth then would be a perfect Sphere.

But it is a Law, for all Bodies that deſcribe Circles, to endeavour to fly off from the Center of the Circle they deſcribe, and this their natural effort, is called their Centrifugal Force; and we know that if equal Bodies deſcribe different Circles in equal Times, their Centrifugal Forces will be as the Circles they deſcribe.

If then the Earth comes to revolve upon its Axis, each of its parts will acquire a Centrifugal Force, in proportion to the Circle deſcribed; that is, the greater the nearer to the Equator, this Force diminiſhing away to nothing at the Poles.

Now tho' it is under the Equator only that this Force would make the parts fly directly off from the Center of the Sphere, while every where elſe it would make them fly off only from the Center of the Circle deſcribed; yet by decompounding this Force, ſo much the leſs the farther it is from the Equator, it is plain that there is a part of it which always tends to hurry the Parts of the Fluid from the Center of the Sphere.

Fig. 1. P. 43.

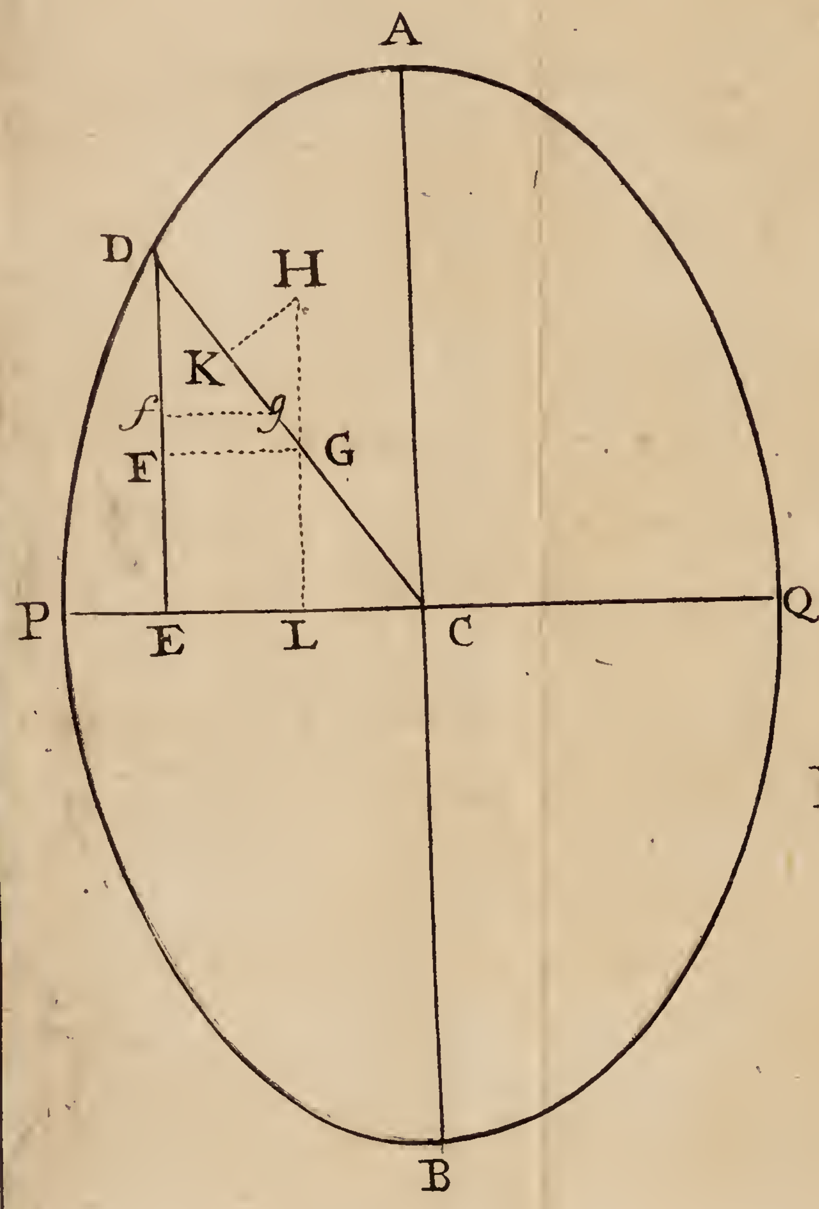
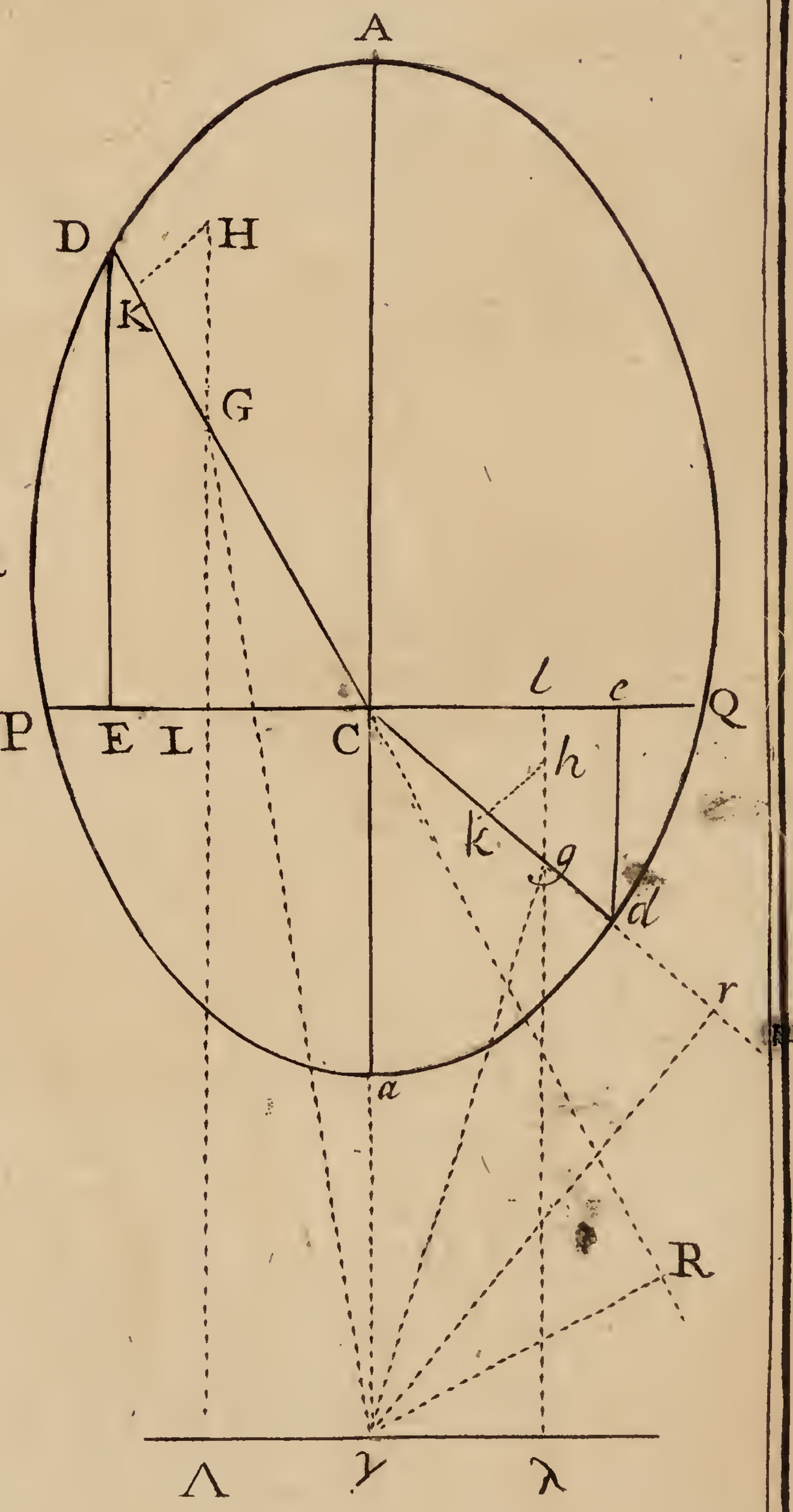


Fig. 2. P. 53.



Herein this Force is abſolutely contrary to Gravity, and muſt deſtroy a part of it, more or leſs, according to their proportion to each other. The Force then which urges Bodies to fall, or Gravity, being unequally diminiſhed by the Centrifugal Force, it will not be the ſame every where, and will ever be the greater where the Centriſugal Force is the leaſt.

We have ſeen it is under the Equator that the Centriſugal Force is greateſt; and there it muſt conſequently be, that Gravity ſuffers the greateſt diminution; Bodies will fall then ſlower under the Equator than any where elſe; and the Vibrations of a Pendulum muſt be retarded in proportion as it is removed towards the Equator, and thus Mr. *Richer*'s Pendulum, removed from *Paris* to *Cayenne*, which is but 4^{d} 55^{m} from the Equator, muſt have gone ſlower.

But the Force which makes Bodies fall is the very ſame that makes them heavy; and not being the ſame every where, it follows that all our fluid Columns, if they are of equal length, will not weigh every where alike; the Column that correſponds with the Equator, will weigh leſs than the Column that correſponds with the Pole; in order therefore for the former to be in æquilibrio with the latter, it would be neceſſary for it to contain a greater quantity of Matter; it ought to be longer.

The Earth then will be higher at the Equator than at the Poles, and the more oblate towards the Poles, the greater the proportion of the Centrifugal Force; or, in other words, the Earth will be ſo much the more oblate, the more rapid its revolution is about its Axis, for the Centrifugal Force muſt encreaſe with this Rapidity.

But if Weight or Gravity were uniform, that is, the ſame at all diſtances from the Center of the Earth, as *Huygens* ſuppoſed, this Flatning has its Bounds. He has demonſtrated That if the Earth moved about its Axis ſeventeen times faſter than it does, it would receive the greateſt Oblateneſs poſſible, inſomuch that the Diameter of the Equator would be double of the Axis. A ſtill greater degree of Rapidity in the motion of the Earth, would produce a Centrifugal Force ſuperior to Gravity,and the Parts would diſperſe.

Huygens did not ſtop here; having determined what Proportion the Centrifugal Force has to Gravity, under the Equator, he inveſtigated what muſt be the Figure of the Earth, and found that the Diameter of the Equator muſt be to the Axis as 578 to 577.

Sir *Iſaac Newton* depending on a different Theory, and conſidering Gravity as the Effect of the Attraction of the Parts of Matter, does not determine the Figure of the Earth in general, and only aſcertains the Proportion between the Diameter of the Equator and the Axis, which he finds to be as 230 to 229.

Herman alſo has examined into the Figure of the Earth by the Hypotheſis of a Gravity proportional to the diſtance from the Center, and found that the Earth muſt be an Ellipſoid whoſe Equatorial Diameter is to its Axis as $\sqrt{289}$ to $\sqrt{288}$; in which he agrees pretty nearly with *Huygens*.

None of theſe Meaſures agree with that actually taken by *Caſſini* and *Maraldi*; but if from their Obſervations, the moſt famous perhaps that ever were made, it follows that the Earth, inſtead of being an oblate Spheroid towards the Poles, is an oblong, tho' this Figure ſeems to be repugnant to the Laws of Statics; we ſhould ſee this to be an abſolute Impoſſibility, before we cavil with ſuch Obſervations.

In the ſeveral Calculations we juſt now mentioned, the Earth was conſidered as compounded of an Homogeneous and fluid Matter; and in this Caſe would moſt certainly be an oblate Spheroid at the Poles: but ſuch an Homogeneity may not be in the Matter which forms the Earth; and for that Reaſon it is of a different Figure.

I will not here examine into the Manner how *de Mairan* thought we might be ſure the Earth is an oblong Spheroid at the Poles; it has been ſufficiently diſcuſſed in the Memoirs of the Academy*, and the Philoſophical Tranſactions †.

CHAP. II.

A Metaphyſical Diſcourſe on Attraction.

I Propoſe here to offer ſome probable Conjectures, whereby to explain how it happens that the Stars ſeem ſometimes to increaſe and decreaſe in Magnitude: how new Stars ſeem ſometimes to be lighted up in the Heavens, or old ones to go out; in a word, how a Ring like *Saturn*'s may be formed around a Planet.

Theſe *Phænomena* are, as we may ſay, no more than the Corollaries to the Problems whereby I demonſtrate the Figure which muſt be aſſumed by a Maſs of fluid Matter revolving about an Axis, or a Stream which circulates about an Axis taken out of itſelf.

Theſe Forms depend upon the Gravity of the parts of theſe Fluids, and their Centrifugal Force. Philoſophers are perfectly agreed as to what concerns this laſt; but they vary from each other on the Subject of Gravity.

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* *Memoires de l'Acad.* 1720. † *Philo. Tranſ.* 1725. No. 386. 387. 388.

Bodies that revolve inceſſantly endeavour to eſcape in the Tangent of the Curve they deſcribe, and this their effort is called their Centrifugal Force.

As for Gravity, ſome look on it as the Effect even of the Centrifugal Force of ſome Matter, which circulating about the Bodies towards which others gravitate, impels or forces them down to the Center of its Circulation; others without diving into the Cauſe, reckon it to be a property proportionably inherent in all Bodies.

Tho' the Mathematical Solutions of the Problems in this Tract, bear no relation to the nature of Gravity; yet as the Application I make of them to the *Phænomena* of Nature, depend in ſome ſort thereon; it may be proper to touch a little on it here, to ſhew how far our Explications may extend, according to the different Ideas we may have of Gravity.

It is not for me to pronunce upon a doubt which divides the greateſt Philoſophers; but I may have leave to compare their Notions.

A Body in Motion, meeting with another Body has the Power to move it. Upon this Principle the *Carteſians* endeavour to explain every Thing, and to evince that even Gravity is but conſequential thereto. Their Syſtem has, in this, the advantage of Simplicity;

city; but it muſt be confeſſed that great Objections are ſtarted againſt it, and occur in our Reſearches by this Syſtem.

Sir *Iſaac Newton* not ſatisfied with the *Carteſian* Doctrine, which accounts for every thing by Impulſion only, diſcovers another active Principle in Nature, meaning that the Parts of Matter gravitate towards each other. This Principle laid down, he wonderfully unravels every *Phænomenon*; and the more we purſue him, the deeper do we dive into his Syſtem, and the more does it ſeem to be confirmed. But beſides that the foundation of this Syſtem is leſs ſimple, in that it ſuppoſes two Principles; a Principle whereby Bodies at a Diſtance act upon each other, appears hard to admit.

The word Attraction has chafed the Minds of Men; many were afraid of ſeeing the Doctrine of occult Qualities revived again in Philoſophy.

But to do juſtice to Sir *Iſaac*, he never thought Attraction to be explanatory of the Gravitation of Bodies towards each other; he often takes notice that he uſed that Term only to expreſs an Effect, not a Cauſe; that he applied it only to avoid Syſtems and Explanations; that poſſibly this Tendency might be cauſed by ſome ſubtile Matter which might emanate from Bodies, and might be the Effect of an actual Impulſion; but be it what it would, it was certainly a primary Effect, whereby might be explained all the ſubſequent Effects dependant thereon. Every regular Effect, may, tho' its cauſe be unknown, be the object of Mathematicians; becauſe whatever is ſuſcipient of *More* or *Leſs*, is within their Sphere, be its Nature what it will; and the Uſes they make of it will be to the full as demonſtrative, as the Applications they may make of Objects whoſe Nature ſhould be abſolutely known. If we were allowed to treat on ſuch only, the Bounds of Philoſophy would be ſtrangely narrow.

Galileo, tho' ignorant of the Cauſe why Bodies gravitated towards the Earth, has nevertheleſs obliged us with a very fine and certain Theory upon this ſame Gravitation, and explained the *Phænomena* thence ariſing. If Bodies ſtill continue to gravitate towards each other, why may we not inveſtigate the Effects of this Gravitation, without diving into the cauſe of it. Our whole Buſineſs will then be to enquire whether or no it be true that Bodies have this Tendency towards each other; and if we find the thing to be a fact, let that content us for our deductions with reſpect to the *Phænomena* of Nature; and let us leave it to ſublimer Philoſophers to ſearch into the Cauſe of this Tendency.

And this to me ſeems to be rather the beſt way, as I believe it in vain for us to trace up to the primary Cauſes of Things; and that we are unable to comprehend in what manner Bodies act upon each other.

But ſome of thoſe who reject Attraction, look upon it as a Metaphyſical Monſter; and believe its impoſſibility ſo fully proved, that however Nature might ſeem to favour it, it were better to acquieſce in a total Ignorance, than to make uſe of ſo abſurd a Principle: let us ſee therefore if Attraction, tho' conſidered as a Property in Matter, implies any Abſurdity.

If we had perfect Ideas of Bodies; if we well knew what they are in themſelves, and what their Properties; how, and in what number reſident in them; we ſhould be able to pronounce whether or no Attraction is a Property in Matter: But we, ſo far from being ſufficiently informed; know Bodies but by ſome Properties only, without the leaſt knowledge of the Subject in which theſe Properties are reunited.

We perceive ſome different Aſſemblages of theſe Properties; and this ſuffices for our Ideas of ſuch and ſuch particular Bodies; we go a ſtep further; we diſtinguiſh different Orders or Claſſes of theſe Properties. We obſerve that while ſome of them vary in different Bodies, others of them are always the ſame, and theſe therefore we eſteem as the primordial Properties, and as the Baſes of the reſt.

The leaſt Attention will conclude that Extenſion is one of theſe invariable Properties. It is ſo univerſal in all Bodies, that I am apt to think the other Properties cannot ſubſiſt without it, and that it is their Support.

I find alſo that there is no body but is ſolid or impenetrable; I then again look upon Impenetrability to be an eſſential Property of Matter.

But is there any neceſſary Connection between theſe Properties? Could not Extenſion ſubſiſt without Impenetrability? Ought I to foreſee by the Property of Extenſion, what other Properties ſhould or would attend it? This is what I can by no means apprehend.

After theſe primitive Properties of Matter, I diſcover others, which, tho' not always peculiar to all Bodies, are nevertheleſs always peculiar to them, when in a certain State; I here mean the Property Bodies have when they move, of moving others in their way.

This Property, tho' leſs univerſal than the two already mentioned, ſeeing it has no relation to Bodies but when in a certain State, may however be taken in ſome ſort, for a general Property relatively to that State, it being obſervable in all Bodies when in Motion.

But once more, is the Aſſemblage of theſe Properties neceſſary? And are all the general Properties of Bodies reducible to theſe? It ſeems to me, that it were an ill way of arguing in the Perſon who ſhould ſo reduce them.

It would be ridiculous in us if we attempted to aſſign other Properties to Bodies, than Experience has pointed out to us; it would be more ſo, if upon ſo ſlender an Information of a few Properties ſcarce known, we preſum'd to pronounce dogmatically that there is no other; as if we had the Meaſure of the Capacity of the Subject, when we know it but by ſo ſmall a number of Properties.

We have a right to exclude no Property that is not contradictory to thoſe we know to be in a Subject; Mobility being a Property in Matter, we may ſay that Immobility is not ſo, and Matter being impenetrable, cannot be alſo penetrable: identical Propoſitions, which are all we are allowed in this Caſe.

Theſe are the only Properties we may poſitively exclude: But have Bodies, beſides the Properties we know in them, that alſo of gravitating or tending towards each other; or of &c. It is to experience that we are indebted for the Knowledge of the other Proties in Bodies, and on the ſame muſt we rely for this additional Information.

I flatter my ſelf I ſhall not be here ſtopped to be told, that this Property in Bodies, of gravitating towards each other, is more inconceivable than thoſe every body admits. The manner how Properties reſide in Bodies is what we cannot conceive. The common People are not at all ſurprized when they ſee a Body in motion communicate its Motion to others, for being uſed to this Sight they ſee nothing wonderful in it: but Philoſophers who are reſolute enough to decide *a priori* concerning what Properties are to be admitted in Bodies, and what excluded; ſuch Philoſophers I ſay cannot conceive the impulſive Force more conceivable than the attractive. What is this impulſive Force? How does it reſide in Bodies? Who could have imagined it to have been reſident therein, before he had ſeen the ſhock or congreſs of Bodies? The Reſidence of the other Properties in Bodies is not a whit more conſpicuous. How comes it that Impenetrability and the other Properties are concomitant with Extenſion? Theſe will be eternally Myſteries to us.

But perhaps it may be ſaid, that Bodies have no impulſive Force. A Body communicates no Motion to the Body it ſtrikes; it is God himſelf that moves the Body ſtruck, or has eſtabliſhed Laws for the communication of theſe Motions; but this is talking at random: For if Bodies in Motion have not the Property of moving others; if when one Body ſtrikes another, this is moved only becauſe God moves it, and has eſtabliſhed Laws for this diſtribution of Motion; how ſhall we be able to aſſure ourſelves that God may not have ordained the like Laws for Gravitation. The Minute we recur to an Almighty Agent, and the Negative only is conſidered, it ſhould be ſaid that ſuch Laws imply a Contradiction; but this can never be advanced, and then is it more difficult for God to make two Bodies tend or move towards each other at a diſtance, than to have them wait for the ſhock to put them in Motion.

Another Argument that may be raiſed againſt Attraction is, that the Impenetrability of Bodies is a Property on all ſides allowed. This Property granted, a Body that moves towards another cannot continue in Motion, if it does not penetrate it; but Bodies are impenetrable, God then muſt have eſtabliſhed ſome Law to reconcile the Motion of one with the impenetrability of both: Here then is a new Law become neceſſary at the Inſtant of the Congreſs or Shock. But for two Bodies at a diſtance, we ſee no neceſſity for a new Law concerning them.

This to me ſeems the moſt ſolid Objection that can be made to Attraction; yet tho' no anſwer were given to it, it proves no more than that there is no viſible neceſſity for the tendency of Bodies; nor do I intend to make it out here, I only endeavour to evince that this ſame Tendency is poſſible.

But let us examine a little into this Matter; the Properties of Bodies are not as we have ſeen, all of the ſame Order; ſome of them are primordial, and common to Matter in general, inaſmuch as they are always concomitant therewith, as Extenſion and Impenetrability.

Some of them are of a leſs neceſſary kind or Order, and are no more than the State in which Bodies may happen to be, or not be, as Reſt and Motion.

In ſhort there are Properties which more particularly diſtinguiſh Bodies, as Figure, Colour, Smell, &c.

If then it happen that ſome Properties of different Orders are in Oppoſition to each other (for two primordial Properties cannot be ſo) the inferior Property muſt yield, and ſuit it ſelf to the moſt neceſſary, as incapable of Change.

Let us now ſee what muſt fall out when a Body moves towards another whoſe Impenetrability withſtands its Motion. Impenetrability muſt unalterably ſubſiſt; but Motion which is a meer State in which a Body may be, or not be, and may be varied infinite ways, will adapt it ſelf to Impenetrability; for a Body may move or not move, this way or that way, but it muſt always be impenetrably the ſame, and unchangeably impenetrable. Some *Phænomenon* in the Motion of the Body muſt then ariſe, conſequential to the ſubordination of the two Properties.

But to argue in this nature againſt Attraction, were as if we concluded the apparent *Phænomenon* to be more neceſſary than the primary Properties of Matter, without conſidering that this *Phænomenon* ſubſiſts but in conſequence of theſe Properties.

What we have been ſaying does not prove there is any Attraction in Nature, nor did I undertake to prove it. My Deſign was only to enquire whether or no Attraction, tho' conſidered as a Property inherent in Matter, was metaphyſically impoſſible. If ſo it were, all the moſt urgent *Phænomena* in nature could not obtrude it upon the World; but if it appears to be neither impoſſible or contradictory, we may ſafely enquire whether it is proved by *Phænomena* or not. It is in the Syſtem of the Univerſe that we are to endeavour to inform ourſelves whether it be effectively a Principle in Nature; to what degree it is neceſſary for the Explication of *Phænomena*; or whether it be needleſly introduced to explain what may be as well explained without it.

With this regard, I preſume it may not be amiſs, here to exhibit a ſummary View of the two grand Syſtems which at this day divide the Philoſophic World; and will begin with the Syſtem of Vortices, not barely ſuch as *Deſcartes* lays it down, but with all the Improvements that have been offered in favor of it.

I ſhall then proceed to Sir *Iſaac Newton's* Syſtem, ſo far as I ſhall be able, by diveſting it of the Calculations which ſo diſplay the wonderful Harmony of all its parts, and give it ſuch a convincing Force.

CHAP. III.

The Motion of the Planets explained by Vortices.

DEſcartes to account for the Revolutions of the Planets around the Sun, ſuppoſes them imerged in a Fluid, which circulating around that glorious Star, forms the vaſt Vortex which ſweeps them along, juſt like a Veſſel when left to the Tide of a River.

This Explanation, ſo ſimple at firſt Sight, is liable to great Objections, when duly conſidered.

The Planets indeed move round the Sun, but in ſuch a manner as every body now knows.

The Orbits of the Planets are not Circles, but Ellipſes, in whoſe Focus the Sun is. One of the Laws of their Revolution, is, that they go thro' equal Area's in equal Times, and hence the Acceleration of the Planets as they draw nearer and nearer to the Sun; for the right Lines produced from the Place of the Planet to the Sun, being then ſhorter, the Elliptic Arcs gone through by the Planet muſt be proportionably larger, for the Planet to deſcribe an Area equal to the Area it deſcribes at a greater diſtance from the Sun, when the Lines produced as aboveſaid are longer.

All the Planets, we know any thing of, obſerve this Law; not only the primary Planets that revolve around the Sun, but the ſecondary Planets alſo that revolve about ſome primary, as do the Moon, and the *Sattelites* of *Jupiter* and *Saturn*; but here the Area's which are in proportion to the times, are Area's deſcribed about a primary Planet, which to its *Satellites* is as the Sun to the primary Planets. And hence the Orbit of a Planet, and the time of its Revolution being known, you may at every Inſtant find the Place of the Planet.

Another Law gives you the Analogy between the periodical Time of each Planet, and its diſtance from the Sun; a Law as ſcrupulouſly obeyed as the former, which is that the Time a Planet takes in going round the Sun, is as the ſquare Root of the Cube of its mean diſtance from the Sun.

This Law alſo extends to the ſecondary Planets; but in this Caſe the periodical Times and Diſtances, are to be taken from the primary Planets reſpectively. By this Law, the diſtance of two Planets from the Sun, and the periodical Time of the one being given, you may inveſtigate the periodical time of the other; or the periodical Times of two Planets, and the diſtance of one of them being given, you may have the diſtance of the other.

Theſe two Laws being laid down, it is not only ſufficient that we ſay in general why the Planets move round the Sun; we muſt alſo ſhew why they obſerve theſe Laws; or at leaſt what we advance, on their Motion, muſt not be contradictory to theſe Laws.

Seeing that both the diſtances of the Planets from the Sun, and their periodical times are different; the *Vortex* cannot every where be of the ſame Denſity, and the times of its Revolution not the ſame every where.

As each Planet deſcribes equal Area's in equal Times, it follows that the Beds of the *Vortex* Matter have their Velocities in a reciprocal Proportion to their diſtances from the Center.

But, becauſe the periodical Times of the ſeveral Planets, are in proportion to the ſquare Roots of the Cubes of their diſtances from the Sun, it follows that the Velocities of the ſame Beds are in a reciprocal Proportion to the ſquare Roots of their diſtances.

If one of theſe Laws be aſcertained, the other becomes neceſſarily incompatible. If we would have it that the Beds of the *Vortex* have the Velocities neceſſary for each Planet to deſcribe equal Area's about the Sun in equal times; it muſt follow, for Example, that *Saturn* would perform his Revolution in 90 Years, which is quite contrary to Experience.

If on the other hand we would indue the ſeveral Beds of the *Vortex*, with the Velocities required to make the Periodical Times proportional to the ſquare Roots of the Cubes of the diſtances; we ſhall find that the Area's deſcribed by the Planets around the Sun will ceaſe to be equal in equal Times.

I do not here ſpeak of the Objections, raiſed againſt the *Vortices*, which do not ſeem invincible: nor do I ſay any thing of that made by Sir *Iſaac Newton*, by ſuppoſing with *Deſcartes*, that the *Vortex* receives its Motion from the Sun, who revolving about his Axis, would communicate this Motion from Bed to Bed, to the utmoſt verge of the *Vortex*. Sir *Iſaac* had, by the Laws of *Mechanics* ſought after the Velocities of the ſeveral Beds, and found them to be very different from thoſe which quadrate with the Rule of *Kepler*, concerning the proportion between the Periodical times of the Planets, and their diſtances from the Sun. *Bernoulli*, in his fine Diſſertation which won the Academy's Prize, in the Year 1730, has ſhewn that Sir *Iſaac* did not ſufficiently conſider ſeveral Things which alter the Calculation. It is true indeed that the ſaid Thing duly conſidered, the Velocities of the ſeveral Beds are found to differ from what they ought to be for the completion of this Law, but they come ſomewhat nearer than before.

But let the Motion of the *Vortex* proceed from what Cauſe ſoever, the Velocities of the Beds might be brought to agree with one of the Laws we have mentioned; but never with both at the ſame time; and yet theſe two Laws are the one as inviolable as the other.

The more Learned have endeavoured to ſolve this Matter; but *Leibnitz* * in particular could only ſay that, throughout the Orbit deſcribed by each Planet, there muſt be a Circulation he calls *Harmonic*; that is a certain Law of Velocity to make Planets obſerve the Law of deſcribing equal Area's in equal Times; and that at the ſame Time there muſt throughout the whole extent of the *Vortex* be a different Property of making the Planets obſerve the Proportion between their Periodical Times, and their diſtances from the Sun: This is all one of the greateſt Men of the Age could ſay in Defence of the *Vortician* Syſtem.

Bulffinger, in the Diſſertation which won the Prize in 1728, acknowledges and better demonſtrates the neceſſity of this different Law in the Fluid which ſweeps away the Planets. But it is hard to admit of theſe different circular Beds moving with independant and broken Velocities.

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* *Vide Act. Erudit.* 1689. *p.* 82. & 1706. *p.* 446.

There is another Objection to this Syſtem which is not of leſs weight: The ſeveral Beds of the *Vortex*, are nearly of the ſame Denſities with their reſpective Planets, for each of the Planets ſwims in its particular Bed; and theſe Beds move with prodigious Rapidity; yet we ſee that the Comets traverſe them, without any ſenſible alteration of their Courſe. The Comets themſelves may as likely be hurried along by Fluids, which may circulate athwart the Fluids which convey the Planets, without confounding, or diſturbing their Courſe.

Let us now proceed to the Doctrine of Gravity according to this Syſtem.

CHAP. IV.

Of the Gravitation of Bodies towards the Earth, by Vortices.

ALL Bodies fall, when not ſuſtained, and tend to the Center of the Earth. To explain this *Phænomenon*, *Deſcartes* ſuppoſes a *vortex* of Fluid Matter to circulate with great velocity round the Earth, in a direction parallel with the Equator. It is well known that when a Body deſcribes a

Circle, it endeavours to fly off from the Center; every part therefore of this Fluid muſt have this centrifugal Deſire or Endeavour to fly off from the Center of the Circle deſcribed. If then they meet with a Body which has not, or has leſs of this centrifugal Property, the Body muſt yield to their Effort; and the parts of the Fluid having always more of this centrifugal Force than the Body, muſt ſucceſſively take its place, till they have forced it down to the Ground.

This general Doctrine of Gravitation is alſo liable to great Objections, the chief of which are theſe,

HUYGENS *Objects*

1. If the motion of ſuch a *Vortex* was rapid enough to drive Bodies ſo forcibly downwards, it ought to give them ſome horizontal Impulſe, and hurry them along in its own direction.

2. If the cauſe of Gravity be attributed to a *Vortex* that mōves parallel to the Equator, Bodies would not fall towards the Center of the Earth, but muſt fall perpendicularly to the Axis. The fall of Bodies being effected by the centrifugal force of the *Vortex* Matter, and that force tending to remove the ſaid Matter from the Center of every Circle it deſcribes, it muſt every where impel Bodies towards the Center of

every particular Circle; and ſo Bodies inſtead of falling towards the Center of the Earth, would tend perpendicularly to the Axis; but neither of theſe happens. It is ever obſerved that the Tendency of Bodies is invariable, and that they fall perpendicularly to the Surface of the Earth.

It has been the good Fortune of the *Carteſian* Syſtem to meet with able Defenders; Mr. *Saurin* has given a very ingenious anſwer to theſe Objections.

Let us ſee how *Huygens* ſupplies the Defects he diſcovers in the *Carteſian* Syſtem. Inſtead of making the ætherial Matter move all around the ſame Poles, he ſuppoſes it to move in all Directions in the ſpherical Space that contains it; and theſe Motions croſſing each other till they become Circular, the ætherial Matter will at length come to move in ſpherical Surfaces of all Directions.

This Hypotheſis laid down, frees the *Vortex* from two Objections made thereto.

1. The ætherial Matter, the Cauſe of Gravity; circulating in all Directions, it cannot impel Bodies Horizontally like the *Carteſian Vortex*; becauſe the Horizontal impulſe it receives from every Surface of this Matter, is deſtroyed by a contrary Impreſſion.

2. It is plain that in this Caſe Bodies muſt fall towards the Center of the Earth; becauſe the ætherial Matter, which circulates in each ſpherical Superficies, impelling them

towards its own Axis, they muſt tend towards the Interſection of all theſe Axes, which is the Center of the Earth.

This Syſtem accounts for the *Phænomena* of Gravity better than the *Carteſian*; but muſt be confeſſed to be far ſhort of its ſimplicity. It is hard to conceive theſe circular Motions of the ætherial Matter in all Directions; and even thoſe who would give a reaſon for every thing by the impulſe of ætherial Matter, are not ſatisfied with what *Huygens* has offered in favour of it.

Bulffinger, rejecting this complexity of Motion, ſtarts a third Syſtem.

He will have it that the ætherial Matter moves at once round two Axes perpendicular to each other; and tho' this of its ſelf is not eaſy to admit of, he ſuppoſes two other Motions of the ætherial Matter, contrary to the two Former. Here you have four *Vortices*, two againſt two, which croſs each other without any interruption or diſorder.

Thus is it that, by the *Vortician* Syſtem, they account for the two grand *Phænomena* of Nature,

That a fluid Matter circulating about ſweeps the Planets around the Sun: that, in the particular *Vortex* of each Planet, a like motion of Matter impels Bodies towards the Center: Thoughts which naturally enough enter into the Mind.

But Nature more nicely examined will not ſuffer us to adhere to theſe firſt Notions. Thoſe who enter into any Scrutiny of the thing, are obliged in the *Solar Vortex* to admit of the Interruption of the Motions of the ſeveral Beds we have mentioned; and in the *Terreſtial Vortex*, of all the contrary Motions in the ætherial Matter; and indeed 'tis at a very great diſadvantage that a Man undertakes, to account for the *Phænomena* by the aſſiſtance of *Vortices*.

* *Bulffinger.*

Hence it is that an Author * we have often cited, ſays, That notwithſtanding his endeavors to defend the *Vortices*, it may happen that thoſe who reject them, may be the more obſtinately bent againſt them by his manner of pleading for them.

It muſt be confeſſed that hitherto the *Vortices* have not been ſatisfactorily reconciled with the *Phænomena*; but we are not therefore to conclude the abſolute impoſſibility of them; nothing can be finer than the Notion of *Deſcartes*, who would have every Thing, in Phyſics, explained by Matter and Motion; but to keep up the Beauty of this Notion, we muſt not go and ſuppoſe Matters and Motions, only becauſe we ſtand in need of them.

Let us now ſee how Sir *Iſaac Newton* accounts for the Motion of the Planets, and Gravity.

CHAP. V.

The ſame Phænomena *explained by the* Newtonian *Syſtem.*

SIR *Iſaac Newton* in the firſt place demonſtrates, that if a Body in Motion be attracted towards a moveable or an immoveable Center, it muſt deſcribe equal Area's, about that Center, in equal Times; and inverſely if a Body deſcribes equal Area's about a moveable or an immoveable Center in equal Times, it is attracted towards that Center.

This demonſtrated by Arguments of the moſt ſound Geometry, he applies it to the Planets, by him conſidered as moving in a void, or in ſpaces ſo thinly interſperſed with Matter, as to be of no ſenſible Reſiſtance to the Bodies that move therein: And it appearing by Obſervation that all the primary Planets revolve about the Sun, and all the Secondaries around their Primaries, in ſuch a manner that they deſcribe equal Area's in equal Times, he concludes that the Planets are attracted towards the Sun, and the *Satellites* towards their Principals reſpectively.

Whatever the Law of this Force which attracts the Planets, may be; that is, in what

Degree ſoever it increaſes and decreaſes, according to the diſtances of the Planets, it in general ſuffices that they are attracted towards a Center, for the Area's they deſcribe to be in proportion to the Times; but by this Proportion alone we cannot diſcover the Law of this Central Force.

But if one of *Kepler*'s Analogies (thus it is they call that proportionality between the Area's and Times) points out a Central Force in general, this gives us the Law of this Force.

This other Analogy, as we have ſeen above, relates to the proportion between the Periodical Time of each Planet, and its diſtance from the Sun. The Periodical Times of the Planets about the Sun, and of the Secondaries about the Primaries, are as the ſquare Roots of the Cubes of their diſtances from the Sun, or any Primary.

This Proportion between the Periodical Times and the diſtances once known, Sir *Iſaac* inquires in what Degree, or by what Law the Central Force muſt increaſe and decreaſe, for Bodies that move by ſuch a force in circular Orbits, or nearly circular, to obſerve this Proportion between the Periodical Times and the Diſtances; and by Geometry it is eaſily demonſtrated that this other Analogy ſuppoſes the force that attracts the Planets towards the Center, or rather the Focus of the Curves they deſcribe, to be in a reciprocal Proportion to the ſquares of their Diſtances from the Center, that is, it decreaſes as the ſquares of the Diſtances increaſe.

Theſe two Analogies ſo difficult to reconcile according to the Doctrine of *Vortices*, are here Facts which diſcover to us this Central Force, and the Law of the ſame.

To ſuppoſe this Force and its Law, is not building a Syſtem; it is diſcovering the Principle whoſe Effects obſerved, are its neceſſary Conſequences. Gravitation towards the Sun is not laid down to account for the Revolutions of the Planets; but the very Courſe of the Planets tell us there is a Gravitation towards the Sun, and what is its Law. Let us now ſee what uſe Sir *Iſaac* is going to make of the Principle he thus diſcovers.

Aſſiſted by the moſt ſublime Geometry, he inveſtigates the Curve which muſt be deſcribed by a Body, that with a rectilinear Motion at firſt, is diverted therefrom towards a Center, by a Force whoſe Law is ſuch as he has diſcovered.

And the Solution of this fine Problem informs him that a Body muſt, in ſuch a Caſe, neceſſarily deſcribe ſome one of the Conic Sections, and that if the Courſe held by the Body returns into itſelf, as happens to the Planetary Orbits, this Curve muſt be an Ellipſis in whoſe Focus the Central Power muſt reſide.

If Sir *Iſaac Newton* was indebted to the two firſt Analogies, for his diſcovery of attraction and its Law, he here ſees them confirmed by new *Phænomena:* All Obſervations make it appear that the Planets do move in Ellipſes, in whoſe Focus is the Sun.

The Comets ſo deſtructive to the Syſtem of *Vortices*, contribute to confirm the *Newtonian* Syſtem.

Sir *Iſaac* having found that Bodies which move about the Sun, tend towards him, by a certain Law, or in a certain Proportion, and muſt deſcribe ſome Conic Section, as do the Planets whoſe Orbits are Ellipſes; conſiders the Comets as Planets that move by the ſame Law, whoſe Orbits are alſo Ellipſes, but ſo very long that, without any ſenſible Error, they may be taken for *Parabola*'s.

But he does not ſtop at this, tho' ſo much in favour of him, he muſt have ſome thing more certain and exact. It muſt be ſeen whether the Orbit of a Comet, determined by Points given in the firſt Obſervations, and attraction towards the Sun, will quadrate with the trace the Comet really deſcribes in the remainder of its Courſe. To this purpoſe he calculated, he and the learned Aſtronomer Dr. *Halley*, the Orbits of the Comets by the Obſervations of which we are enabled to make the Compariſon; and it cannot without aſtoniſhment be ſeen that the Comets have appeared in the points of their Orbits ſo determined, almoſt as exactly as the Planets appear in the Places of their Orbits, as ſettled by the common Tables.

This Theory ſeems to want nothing but a pretty long ſeries of Obſervations, to bring us acquainted with each Comet, and to enable us to foretel its return, as we do that of the Planets to the ſame Points of the Heavens. But Stars, whoſe Revolutions, to all appearance, are of ſome Centuries Duration, ſeem but ill adapted for the Obſervation of Man whoſe Life is ſo ſhort.

Here you have the Revolutions of the Planets and Comets, all the *Phænomena* made out by one ſingle Principle; and may not the laws of Gravity be explained ſtill by the ſame Principle?

Bodies fall towards the Center of the Earth; it is the attraction of the Earth which makes them fall; but this Explication is too vague.

If the quantity of the attractive Power of the Earth, were known by any indication beſides the fall of Bodies, we might ſee whether the fall of Bodies, according to the known Laws, is the effect of this Power or Force.

We ſee that the Sun attracting the Planets, is the Cauſe why they move round him, as the attraction of the Primaries confines their Secondaries; now the Moon is the Earth's Secondary or *Satellite*, it is the attraction of the Earth therefore that makes the Moon turn round us.

The Orbit of the Moon, and the Time it takes up in moving about the Earth are well known; and thence we may come at the ſpace attraction would draw the Moon through, towards the Earth, in a given time, if the Moon deprived of Motion ſhould tend towards the Earth in a right line by the cogency of this ſame Force.

The mean diſtance of the Moon from the Earth being about 60 Semi-diameters of the Earth, it is by a ready Calculation found, that the degree of attraction the Earth exerciſes upon the Moon, in the region where ſhe is, would make her fall through 15 Foot in a Minute.

But attraction increaſing as the ſquares of the Diſtances decreaſe; if the Moon or any other Body were 60 times nearer to the Surface of the Earth than ſhe happens to be, the attraction of the Earth would be 3600 ſtronger, and the Body would fall through 3600 times 15 Foot in a Minute; for Bodies, when they begin to move, run through ſpaces proportional to the moving Power.

Now, by *Huygens*'s Experiments, we know the ſpace a Body falls through, by its own Gravity meerly, towards the Center of the Earth; and this ſpace is preciſely the ſame as the Force which retains the Moon ought to make a Body run through, increaſed as it ought to be towards the Center of the Earth.

The Fall of Bodies then towards the Earth is an effect of this ſame Force; whence we gather that the gravity of Bodies is the greater, the nearer they are to the Center, and ſo on inverſely; tho' the greateſt Diſtances we can make Experiment upon are too inconſiderable for us to be ſenſible of this difference of Gravity.

Particular Experiments, have taught that the gravity of Bodies, cauſed by this attraction, at equidiſtance from the Center of the Earth, is as their quantities of Matter.

This Force then which attracts Bodies towards the Center of the Earth, acts proportionably upon all the parts of Matter.

Now attraction is always mutual or reciprocal; one Body cannot attract another without being proportionably attracted thereby. If the attraction of the Earth, upon every part of Matter be equal, every part of Matter attracts the Earth in its turn; and an Atom cannot fall towards the Earth but the Earth muſt riſe to meet it.

Thus it is that the Motions of the Planets are amply illuſtrated by the Principle of attraction; and the gravity of Bodies is but a Conſequence of the ſame.

I do not here ſpeak of the very inconſiderable Anomalies, that may be either paſſed over, or explained by this Principle.

For Example, the Sun is ſuppoſed to be immoveable in the Focus of the Ellipſes deſcribed by the Planets; and yet he is not abſolutely immoveable; attraction being always mutual, the Sun cannot attract the Planets but he muſt be attracted by them: Strictly ſpeaking, then the Sun continually changes Place according to the different poſitions of the Planets; ſo that it is only the Center of gravity of all the Planets and the Sun that is immoveable; but the enormity of the Sun is ſuch to the Planets, that were they all together on one ſide, the diſtance of the Center of the Sun from the common Center of Gravity, which is then the greateſt that can be, would not be one only of his Diameters.

The ſame is to be underſtood of every Planet that has *Satellites:* The Moon, for Example, ſo attracts the Earth that her Ellipſis about the Sun is not deſcribed by her Center, but by the common Center of Gravity of the Earth and Moon, while each of theſe Planets performs a Revolution about this Center of Gravity in the ſpace of a Month.

The mutual attraction of the other Planets cauſe no ſenſible change in their Courſe; *Mercury*, *Venus*, the Earth, and *Mars*, are not ſo large as to be able to act upon each other to a degree of Senſibility. Their revolutionary Motion can only be diſturbed by *Jupiter* and *Saturn*, or ſome of the Comets who might cauſe ſome diverſion in the Aphelia of theſe Planets, but ſo very inconſiderable and ſo ſlow as not to be minded.

But it is not ſo with the mutual attraction between *Jupiter* and *Saturn*; theſe two mighty Planets reciprocally diſturb each other, when in Conjunction, and that, to a degree conſiderable enough to be obſerved by Aſtronomers.

Thus is it that attraction and its Law being once ſettled with regard to the Area's the Planets deſcribe about the Sun, and the Times; and with regard to the Periodical times of the Planets, and their diſtances, the other *Phænomena* are but neceſſary Conſequences thereof. The Planets muſt deſcribe the Curves they do deſcribe; Bodies muſt fall towards the Center of the Earth, and their fall muſt be as violent as it is; and in ſhort the Planets are ſubject to ſuch diſturbances in their Courſe as muſt naturally reſult from this attraction.

One of the effects of attraction, namely, the fall of Bodies, is plain enough; but this effect even is what prevents us from diſcover- the attraction of Bodies towards each other. The Power or Force of attraction being as the quantities of Matter in Bodies, the attraction of the Earth upon every Body whatſoever, hinders our ſeeing the effects of their own attraction; for urged towards the Center of the Earth by an immenſe Force, their mutual attractions become inſenſible, as a Storm deſtroys the lighteſt Breath.

But if we extend our View to what can manifeſt their attraction upon each other, we ſhall find the effects of attraction as continually repeated as thoſe of Impulſion. The Motions of the Planets declare themſelves every Inſtant, while impulſion is a Principle which Nature ſeems to employ but in ſmall.

Attraction being no leſs poſſible in the Nature of Things than Impulſion, the *Phænomena* which indicate Attraction being as frequent as thoſe that plead for Impulſion; when we ſee one Body tend towards another, to ſay that it is not attracted, but that it is puſhed along by an inviſible Matter, were much the ſame as if a favourer of Attraction, who ſhould ſee one Body put in motion by another, ſhould ſay it does not move by the effect of Impulſion, but by the attraction of ſome inviſible Body.

I now leave the Reader to judge whether or no Attraction be ſufficiently made out by Facts, or whether it is but a mere *gratis dictum* we may do without.

For my part I confeſs I know not what this gravity of Matter may be, and that I am as ignorant with reference to its impulſive Force. If it could be made out that the one depends upon the other, it would moſt aſſuredly ſimplify the Syſtems; but in the mean time I believe that without preferring the one to the other, we may make uſe of both.

CHAP. VI.

Of the Differences wherewith the various Nature of Gravity muſt affect the Figure of Fluids, that turn about an Axis.

I Return now to conſider what the ſeveral Syſtems may alter in the application I make of the following Problems to the *Phænomena* of Nature.

In theſe Problems I determine the Figure that ought to be aſſumed by a Maſs of homogeneous and fluid Matter, which revolves about an Axis, or a torrent of the ſame Matter which turns around an Axis which is not its own, or taken without itſelf.

For Bodies to arrive at permanency of Figure, all their parts muſt be in perfect equilibrio. Now theſe parts are animated by two Forces, on which this *Æquilibrium* muſt depend; the one, the Centrifugal Force they acquire by their Revolution, tending to remove them from the Center; the other, which is Gravity, tending thereto. As for the Centrifugal Force there is a perfect agreement about that; it is no more than the Effort of all Bodies that circulate, to go wide of the Center of their Circulation; and proceeds from the Force wherewith all Bodies endeavour to perſevere in the ſtate they are once in, of Reſt or Motion. A Body forced to move in the direction of ſome Curve, continually endeavors to eſcape by the Tangent of that Curve; becauſe at every inſtant its ſtate is to move in the ſtrait direction of the very ſmall right lines which compoſe the Curve, and whoſe prolongations are the Tangents. The nature then of this Centrifugal Force which is one of the Elements of the following Solutions, and its effects, are well known; and the uſe I have here made thereof is liable to no Objection.

But it is not ſo with Gravity; it is neceſſary to ſhew the alterations it may cauſe in the following Reſolutions, according as it is conſidered either as an effect of Impulſion, or as a property of Bodies.

If Gravity be imputed to the impulſe of ſome matter that drives Bodies downwards, as *Deſcartes* and *Huygens* ſuppoſe, the Force that ſo animates Bodies to tend towards the Center, will be independent of the Body that may be in the Center, and of its Figure; if the Earth, for example, ſhould not be in the Center of the *Terreſtrial Vortex*, or were of a different Figure from what it is, Bodies would nevertheleſs always tend to the Center of the *Vortex*, and with the very ſame rapidity as at preſent. Conſidering therefore, in theſe Problems, the gravity of the parts of Bodies, as inclining towards a Center independent of the figure of theſe Bodies, it is ſeen that the ſolution of theſe Problems muſt give the true Figures the cœleſtial Bodies may be of, by fixing the Law according to which Gravity increaſes and decreaſes proportionably to the diſtance from the Center.

But if we conſider Gravity as an inherent property in Matter, if the parts of Matter attract each other as the *Newtonians* teach, whence ariſes gravitation towards central Bodies; Gravity muſt then depend on their quantities of Matter and their Figures.

Sir *Iſaac Newton* has demonſtrated that ſpherical homogeneous Bodies, attract Bodies without them in a reciprocal proportion to the ſquare of their diſtance from the Center; and that the gravity of their interior parts is as their diſtance from the Center. But in Bodies of different Figure, Gravity obeys not theſe Laws; it obſerves others that ariſe from the Figure of theſe Bodies. And hence Sir *Iſaac* taking this into Conſideration when he ſought after the length of the Earth's Axis, and the Diameter of the Equator, found them to be to each other as 229 to 230, a proportion different from *Huygens*'s and ours.

What is here taught concerning the Figures of the Planets and the Suns, ought not then to be taken for abſolutely granted. But if, as ſome Philoſophers will have it, or as is very poſſible, there are, in Bodies, *Molæ* or Nuts of Matter much more denſe than the reſt; the parts without the Nut will gravitate towards its Center, nearly as Bodies gravitate towards the Spheres without which they are; and the Figures I determine will approach nearer to the true Figures. This ought to be ſtill more conſidered with regard to the Atmoſpheres of the heavenly Bodies, the denſity of the Fluids that ſurround them being very inconſiderable in compariſon of theirs.

The ſame is it with the *Vortices* which move around the Planets; they may be ſo very rare in proportion to the Planets, that the mutual gravitation of their parts may be paſſed over, and conſidered as nothing with regard to gravitation towards the Planets. Admitting therefore the matter of theſe *Vortices* as gravitating towards the Center of any Planet, in an inverſe *Ratio* of the ſquare of its Diſtance, the figure of the Rings they form, will come very near to truth.

CHAP. VII.

A Mathematical Inquiry into the Figures that muſt be aſſumed by Fluids, that revolve about an Axis.

PROBLEM I.

To find the Figure of a fluid Spheriod that turns about its Axis, ſuppoſing every part of the Fluid to gravitate towards the Center, according to any power whatſoever of the diſtance from that Center.

SOLUTION.

LET PQ be the Axis of Revolution, and PAQB the ſection of the Spheroid by the Axis. Seeing the parts of the Fluid are at reſt within themſelves, every Column gravitates equally towards the Center C; taking then one of theſe Columns CD, which together with CP forms an Angle whoſe Radius being = 1, its Sine = h, I conſider it as compounded of infinite ſmall Cylinders Gg; and I want the gravity of each of them towards C.

The abſolute gravity being given in A, $=p$, to have the gravity in G, ſay $p . p :: CA^{n}$. CG^{n}, whence you have the Gravity in G, or $p' = \frac{p . CG^{n}}{CA^{n}}$.

F I G. I.

But the revolutionary Motion actuating every Part of the Fluid with a centrifugal Force, according to GH, and in Bodies that perform their Revolutions in the ſame times, the centrifugal Force being as the Radii of the Circles they deſcribe; if the centrifugal Force in A be given, and $=f$, to have the centrifugal Force in G, ſay $f . f' :: CA . LG =$ (becauſe of $LG . CG :: h . 1$) $h . CG$; whence you have the centrifugal Force in G, or $f' = \frac{fh . CG}{CA}$: But this Force acting according to or in the Direction of GH, does not diminiſh the Force according to GC, but in that it acts in the contrary Direction according to GD. To find then this Force according to GD, you have $GH . GK$, or $1 . h :: \frac{fh . CG}{CA} . f'' = \frac{fhh . CG}{CA} =$ to the Force which draws the ſmall Cylinder according to GD.

The Force then that draws the ſmall Cylinder

Gg according to GC, is then no more than $\frac{p.CG^n}{CA^n}-\frac{fhh.CG}{CA}$; and the Gravity of the ſmall Cylinder towards C, will be $\left(\frac{p.CG^n}{CA^n}-\frac{fhh.CG}{CA}\right)Gg$. The Gravity of the Column CG, compounded of theſe ſmall Cylinders, will be then $\int\left(\frac{p.CG^n}{CA^n}-\frac{fhh.CG}{CA}\right)Gg$, or $\frac{p.CG^{n+1}}{(n+1)CA^n}-\frac{fhh.CG^2}{2CA}$; and the weight of the whole Column CD will be $\frac{p.CD^{n+1}}{(n+1)CA^n}-\frac{fhh.CD^2}{2CA}$ which muſt be a certain Weight or Gravity A.

If then we make $CA=a$, $CD=r$, you will have $\frac{pr^{n+1}}{(n+1)a^n}-\frac{fhhrr}{2a}=A$; and this Equation taking place, let h be what it will, it is plain that h being ſuppoſed to be variable, the Equation will give the Proportion of every Radius CD and the Sine of the Angle it forms with the Axis PQ, and conſequently give all the Points of the Curve.

We muſt now determine the certain Quantity A. That the foregoing Equation may belong to the Section of the Spheroid whoſe Semi-axis CA $= a$; when the Angle DCP is right, or when $h = 1$, r muſt be $= a$; then you have $\frac{pa^{n+1}}{(n+1)a^{n}} - \frac{faa}{2a} = \text{A}$ or $\text{A} = \left(\frac{2p-nf-f}{2\,(n+1)}\right)a$.

So the Equation will ſtand thus $\frac{pr^{n+1}}{(n+1)a^{n}} - \frac{fhhrr}{2a} = \left(\frac{2p-nf-f}{2\,(n+1)}\right)a$, or $2\,pr^{n+1} - (n+1)\,fhha^{n-1}rr = (2p-nf-f)\,a^{n+1}$.

This Equation gives the Sections of all the Spheroids, whatever may be the Power of the Diſtance with regard to Gravity, excepting the Hypotheſis only of a Gravity which ſhould be in a reciprocal Proportion to the Diſtance from the Center. In this Caſe we muſt recur to $\int\left(\frac{p\,.\,\text{CG}^{n}}{\text{CA}^{n}} - \frac{fhh\,.\,\text{CG}}{\text{CA}}\right)\text{G}g$, which then becomes $\int\left(\frac{p\,.\,\text{CA}}{\text{CG}} - \frac{fhh\,.\,\text{CG}}{\text{CA}}\right)\text{G}g$, which is no longer integrable but by Logarithms. You have therefore $p\,.\,\text{CA}\,.\,l\,\text{CG} - \frac{fhh\,.\,\text{CG}^{2}}{2\text{CA}}$; or for the Weight of the whole Column, $palr - \frac{fhhrr}{2a} = \text{A}$.

To rectify this Equation, h muſt be $=1$, and $r=a$; and then you have $pala-\frac{fa}{2}=A$; and corrected, $palr-\frac{fhhrr}{2a}=pala-\frac{fa}{2}$; or $2pal\left(\frac{r}{a}\right)=\frac{fhhrr}{a}-fa$; or, going to Numbers, and taking c for the Number whoſe Logarith. $=1$, you have $r=ac^{\left(\frac{fhhrr}{2paa}-\frac{f}{2p}\right)}$.

It is evident that the Meridians of the Spheroids are continually Algebraic Curves, except in this one Hypotheſis.

If you would have the Equation of all theſe Curves in the common way, by co-ordinate Rectangles, it is eaſily done. For, making $CE=x$ and $DE=y$, you will have $rr=xx+yy$, and $hr=y$. Striking out h and r from the general Equation, you will have $2p\,(xx+yy)^{\frac{n+1}{2}}-(n+1)fa^{n-1}yy=(2p-nf-f)\,a^{n+1}$: and for the Caſe $n=-1$, $xx+yy=aac^{\left(\frac{fyy}{paa}-\frac{f}{p}\right)}$

But our firſt Method of finding the Curves, by Radii and Angles, is in this Caſe rather the more convenient of the two.

Though we ſuppoſe h to be variable, it nevertheleſs varies but within certain Limits which are 0 and 1; the radial Equation then only determines the Arc of the Curve whoſe Amplitude is a Right-angle: But theſe Curves being compounded of four ſimilar and equal Arcs; they are entirely aſcertained by our Equation.

We may now readily come at the Proportion between the two Axes of the Section, in any Hypotheſis whatſoever.

The general Equation being $2pr^{n+1} - (n+1) fhha^{n-1} rr = (2p-nf-f) a^{n+1}$; to find r when $h=0$, you have $2pr^{n+1} = (2p-nf-f) a^{n+1}$. Whence you deduce CA . CP : : $(2p)^{\frac{1}{n+1}} . (2p-nf-f)^{\frac{1}{n+1}}$.

And in the Hypotheſis of a Gravity in an inverſe Ratio of the ſimple Diſtance you have $l\left(\frac{r}{a}\right)=\frac{f}{2p}$. Whence you deduce ICA—ICP $=\frac{f}{2p}$.

It is plain that n being a poſitive Number, whether an integer or not, that is, in all the Hypotheſes of a Gravity in a direct Ratio of any Power whatſoever of the Diſtance, the Diameter of the Equator will always exceed the Axis of Revolution. But if n be a negative Number, that is if Gravity be in an Inverſe Ratio of any Power of the Diſtance,

ſtance, you will have CA . CP : : $(2p)^{\frac{1}{-n+1}} . (2p+nf-f)^{\frac{1}{-n+1}}$; now if $n < 1$, let $k = 1 - n$, and you will have CA . CP : : $2p^{\frac{1}{k}} . (2p-kf)^{\frac{1}{k}}$; and if $n > 1$, let $n - 1 = k$, and you will have CA . CP : : $(2p)^{\frac{1}{-k}} . (2p+kf)^{\frac{1}{-k}}$, or CA. CP : : $(2p+kf)^{\frac{1}{k}} . (2p)^{\frac{1}{k}}$. We have moreover ſeen that n being $= -1$, you have $l\left(\frac{CA}{CP}\right) = \frac{f}{2p}$. Whence it is plain that there is no Hypotheſis wherein the Spheroid is not flat at the Poles.

SCHOLIUM.

The Figure of the Spheroids depends then on the proportion between the Centrifugal Force and gravitation. Let us now ſee to what Degree this proportion may vary in ſome Hypotheſes of Gravity, and what Figures would thence reſult in the Spheroids.

If we ſuppoſe Gravity to be uniform; n being $= 0$, you have C A . C P : : $2p . 2p - f$. Upon our Earth the force of Gravity is 289 times greater than the Centrifugal Force under the Equator; if then we would have the proportion between the Diameter of the terreſtrial Equator and the Axis of Revolution, in this Hypotheſis of a uniform Gravity, ſubſtituting 289 for p, and 1 for f, you will have C A. C P : : 578 . 577.

The centrifugal Force might be equal to Gravity, which would actually happen if the Earth revolved 17 times faſter than at preſent; and then you would have C A . C P : : $2p . p$: : 2 . 1 . The Centrifugal Force could not be greater without diſperſing the parts of the Earth; and if the revolutionary Motion ſhould continue to accelerate, the Earth would be reduced to a ſingle Atom at the Center. Whence it is evident that in this Hypotheſis of an uniform Gravity, the flatteſt Figure the Spheroid is capable of, could not make the Diameter of its Equator exceed the double of its Axis of Revolution. In this Caſe the Earth could be compounded of two Paraboloids, as *Huygens* has demonſtrated in his Treatiſe of Gravity, *p.* 157. with regard to this Hypotheſis, the only one he examined.

This Hypotheſis, the moſt ſimple of all, is not to be taken for the only one; for *Herman* in his inveſtigation of the Figure of the Earth, ſuppoſes a Gravity in proportion to the diſtance from the Center. * Let us now ſee what might happen in this Hypotheſis, and what Figure it might give to the Spheroids.

* *Phoron. p.* 366.

You have then ($n = 1$) $CA . CP :: \sqrt{2p} . \sqrt{(2p - 2f)} :: \sqrt{p} . \sqrt{(p - f)}$; and if the Centrifugal Force became equal to Gravity, the Diameter of the Equator would infinitely exceed the Axis of Revolution; that is, the Spheroid would be reduced to a circular Plane. It being, in this Hypotheſis, poſſible for the Centrifugal Force to be in all proportions with the force of Gravity, or Gravitation, from 0 to equality, the Diameter of the Equator may conſequently be in all proportions with the Axis of Revolution. And the Spheroid which in this Hypotheſis is an Ellipſoid, may be all the Ellipſoids from the Sphere to the flatteſt Ellipſoid, which would be no more than a circular Plane. But, according to this Hypotheſis alſo, the Centrifugal Force cannot exceed the force of Gravity.

If we ſuppoſe Gravity to be in an inverſe Ratio of the ſquare of the diſtance from the Center conformably to the *Newtonian* Doctrine, you have $n = -2$; and $CA . CP :: (2p)^{-1} . (2p+f)^{-1}$; or $CA . CP :: 2p+f . 2p$. whence it appears that the Spheroid that continually flattens as the Centrifugal Force increaſes, will nevertheleſs be the flatteſt poſſible, when the Diameter of its Equator is to its Axis of Revolution as 3 to 2.

PROBLEM II.

A Torrent or *Vortex* of fluid Matter circulating about an Axis without the Torrent, by a centripetal Force in proportion to any Power whatſoever m of the diſtance from the Center meaſured from the Axis; and in each Section perpendicular to the Revolution, the Gravity reſulting from the parts of the Fluid towards a Center taken within that Section, being equal to any power whatſoever n of the diſtance from that Center; to find the figure of the Torrent?

SOLUTION.

Let ADP*ad*QA be the Section of the Torrent that turns around the Axis $\mathrm{A}\lambda$, made by a Plane perpendicular to the Revolution, through the Center γ. Let γ be the Center of the centripetal Forces taken without the Torrent, and C the Center towards which is the Attraction reſulting from the Part of the Fluid taken within the Section.

For the parts of the Fluid to be in equilibrio the weight of each Column CD, as well that which proceeds from the Gravitation towards γ and towards C, as well as the centrifugal Force muſt be every where the ſame.

Let then the abſolute Gravity in A towards γ be given, and $=\pi$; let the Gravity in A towards C be alſo given, and $=p$; let alſo the Centrifugal Force in A be alſo given, and $=f$. Let AC$=a$, C$\gamma=b$, CG$=r$; the Sine of the Angle DCP$=h$, the Radius being $=1$; you will have G L $=hr$; and taking away from γ the right Line γR perpendicular to the Radius CD continued, you will have CR$=hb$, and γG$=\surd\ (bb+2bhr+rr)$.

Now the Gravity in A towards γ being $=\pi$; making $\pi\ .\ \pi'\ ::\ (a+b)^m\ .\ (bb+2bhr+rr)^{\frac{1}{2}m}$; you will have the Gravity in G, or π'

$$=\frac{\pi\,(bb+2bhr+rr)^{\frac{1}{2}m}}{(a+b)^m};$$ and to have the Force which thence reſults towards C, ſay $\pi'\ .\ \pi''\ ::$ Gγ . GR, or $\frac{\pi\,(bb+2bhr+rr)^{\frac{1}{2}m}}{(a+b)^m} : \pi'' :: (bb+2bhr+rr)^{\frac{1}{2}}\ .\ bh+r$; whence you will ſee the Force towards C reſulting from the Gravitation towards γ, or $$\pi''=\frac{\pi(bh+r)(bb+2bhr+rr)^{\frac{m-1}{2}}}{(a+b)^m}.$$

You have moreover (the Gravity in A towards C being $=p$) the Gravity in G towards C, $=\frac{pr^n}{a^n}$; the whole weight then towards C, reſulting from the two Gravities toward γ and toward C, will be then $=$

$$\frac{\pi(bb+r)(bb+2bbr+rr)^{\frac{m-1}{2}}}{(a+b)^m}+\frac{pr^n}{a^n}.$$

The centrifugal Force in A being $=f$; if you make $f \,.\, f' :: a+b \,.\, b=hr$, you will have the centrifugal Force in G or $f'=\frac{f(b+hr)}{a+b}$; and to find that part of this Force that draws towards D, ſay $f' \,.\, f'' ::$ GH . GK, or $\frac{f(b+hr)}{a+b} \,.\, f'' :: 1 \,.\, h$; whence, for the Force contrary to the Gravity toward C, you have $f''=\frac{fh(b+hr)}{a+b}$.

You have then for the Force towards C, reſulting from all theſe Forces

$$\frac{\pi(bb+r)(bb+2bbr+rr)^{\frac{m-1}{2}}}{(a+b)^m}+\frac{pr^n}{a^n}-\frac{fh(b+hr)}{a+b}.$$

Conceiving then, as in the firſt Problem, the Column CD to be compounded of infinite ſmall Cylinders dr, you will have

$$\int\left[\frac{\pi(bb+r)(bb+2bbr+rr)^{\frac{m-1}{2}}}{(a+b)^m}+\frac{pr^n}{a^n}-\frac{fh(b+hr)}{a+b}\right]dr,$$

which muſt be a certain Weight. Then you will have $\frac{\pi(bb+2bhr+rr)^{\frac{m+1}{2}}}{m+1\,(a+b)^m}+\frac{pr^{n+1}}{n+1.a^n}-\frac{fbhr}{a+b}-\frac{fhhrr}{2(a+b)}=\mathrm{A}.$

To correct this Equation, when $h=1$, r muſt be $=a$; and then you have $\frac{\pi(a+b)}{m+1}+\frac{pa}{n+1}-\frac{fab}{a+b}-\frac{faa}{2(a+b)}=\mathrm{A}$. And then the Equation will ſtand thus, $\frac{\pi(bb+2bhr+rr)^{\frac{m+1}{2}}}{m+1\,(a+b)^m}+\frac{pr^{n+1}}{(n+1)a^n}-\frac{fbhr}{a+b}-\frac{fhhrr}{2(a+b)}=\frac{\pi(a+b)}{m+1}+\frac{pa}{n+1}-\frac{fab}{a+b}-\frac{faa}{2(a+b)}$. Or (changing c for $a+b$, and q for $(m+1)\times(n+1)$).

$$2(n+1)\pi a^n\times(bb+2bhr+rr)^{\frac{m+1}{2}}+2(m+1)pc^mr^{n+1}-2qfa^nbc^{m-1}hr-qfa^nc^{m-1}hhrr=2(n+1)\pi a^nc^{m+1}+2(m+1)pa^{n+1}c^m-2qfa^{n+1}bc^{m-1}-qfa^{n+2}c^{m-1}.$$

You ſee that in all theſe Hypotheſes the Section of the Torrent is an Algebraic Curve, excepting the Hypotheſes of an Attraction toward γ or towards C in a ſimple inverſe Ratio of the Diſtance.

For if only $m=-1$, the Equation of the Section of the Torrent will be

$$\frac{\pi(a+b)}{2}\,l(bb+2bhr+rr)+\frac{pr^{n+1}}{(n+1)a^{n}}-\frac{fbhr}{a+b}-\frac{fhhrr}{2(a+b)}=\frac{\pi(a+b)}{2}\,l(a+b)^{2}+\frac{pa}{n+1}-\frac{fab}{a+b}-\frac{faa}{2(a+b)}.$$

Or $\frac{\pi c}{2}\,l\left(\frac{bb+2bhr+rr}{cc}\right)=-\frac{pr^{n+1}}{(n+1)a^{n}}+\frac{fbhr}{c}+\frac{fhhrr}{2c}+\frac{pa}{n+1}-\frac{fab}{c}-\frac{faa}{2c}.$

And if only $n+-1$, the Equation will be

$$\frac{\pi(bb+2bhr+rr)^{\frac{m+1}{2}}}{m+1\,(a+b)^{m}}+palr-\frac{fbhr}{a+b}-\frac{fhhrr}{2(a+b)}=\frac{\pi(a+b)}{m+1}+pala-\frac{fab}{a+b}-\frac{faa}{2(a+b)}.$$ Or

$$pal\left(\frac{r}{a}\right)=-\frac{\pi(bb+2bhr+rr)^{\frac{m+1}{2}}}{(m+1)c^{m}}+\frac{fbhr}{c}+\frac{fhhrr}{2c}+\frac{\pi c}{m+1}-\frac{fab}{c}-\frac{faa}{2c}.$$

But if at the ſame time $m=-1$ and $n=-1$, the Equation will be

$$\frac{\pi(a+b)}{2}\,l(bb+2bhr+rr)+palr-\frac{fbhr}{a+b}-\frac{fhhrr}{2(a+b)}=\frac{\pi(a+b)}{2}\,l(a+b)^{2}+pala-\frac{fab}{a+b}-$$

$-\frac{faa}{2(a+b)}$. Or $\frac{\pi c}{2} l\left(\frac{bb+2bhr+rr}{cc}\right)+pal\left(\frac{r}{a}\right)$
$=\frac{fbhr}{c}+\frac{fbhrr}{2c}-\frac{fab}{c}-\frac{faa}{2c}$.

If you would have the Section of the Equation by co-ordinate Rectangles; by making CE$=x$ and DE$=y$, you will have the two Equations $rr=xx+yy$, and $hr=y$; ſo that ſtriking out r and h from the foregoing Equations, you will, for the general Caſe, have

$$2(n+1)\pi a^{n}(bb+2by+yy+xx)^{\frac{m+1}{2}}+2(m+1)$$
$$pc^{m}(xx+yy)^{\frac{n+1}{2}}-2qfa^{n}bc^{m-1}y-qfa^{n}c^{m-1}yy=$$
$$2(n+1)\pi a^{n}c^{m+1}+2(m+1)pa^{n+1}c^{m}-2qfa^{n+1}$$
$$bc^{m-1}-qfa^{n+1}c^{m-1}.$$

In the ſame manner you may have the Equations, in the Caſes $m=-1$ and $n=-1$.

You will alſo find the Curve PaQ as we have found the Curve PAQ, by obſerving the proper Changes.

For then if the Gravity in a towards γ be given and $=\pi$, the Gravity in a towards C$=p$, the centrifugal Force in $a=f$, C$a=a$, C$\gamma=b$, C$g=r$, $gl=hr$, C$r=bh$, and $\gamma g=\sqrt{(bb-2bhr+rr)}$; you will have the Gravity in g towards C reſulting from the Attraction towards γ, $\pi''=\frac{\pi(bh-r)(bb-2bhr+rr)^{\frac{m-1}{2}}}{(b-a)^{m}}$.

You have moreover the Gravity in g towards C, $p' = \frac{pr^n}{a^n}$.

You will alſo have the part of the Centrifugal Force which reſults in g towards C, $f'' = \frac{fh(b-hr)}{b-a}$.

But theſe two laſt forces are contrary to the firſt; you will then have,

$$\int\left[\frac{\pi(-bh+r)(bb-2bhr+rr)^{\frac{m-1}{2}}}{(b-a)^m} + \frac{pr^n}{a^n} + \frac{fh(b-hr)}{b-a}\right]dr = A.$$

Whence you have

$$\frac{\pi(bb-2bhr+rr)^{\frac{m+1}{2}}}{m+1\ \ (b-a)^m} + \frac{pr^{n+1}}{(n+1)a^n} + \frac{fbhr}{b-a} - \frac{fhhrr}{(2b-a)} = \frac{\pi(b-a)}{m+1} + \frac{pa}{n+1} + \frac{fab}{b-a} - \frac{faa}{(2b-a)}.$$

And in the Caſes of $m = -1$, $n = -1$, you will have, as above, the Equation of the Sections that will only differ by the Alteration of ſome Signs.

By theſe radial Equations you will have the Equations from the Co-ordinates, as was done for the Curve PAQ.

And the Weight of the Column, as well in the Superior Curve as the Inferior, being continually the ſame, you will have an Equation be-

between the Weight A in the Superior Curve, and the Weight A in the Inferior, by which you may find the Proportion between C*a* and CA; and thus you may determine the entire Section of the Torrent.

SCHOLIUM.

Let the Hypotheſis of Gravity be what it will, you may always, for a certain Angle DCP, ſo contrive that the Radius CD be of a given Length: And by that means make the Figure of the Torrent more or leſs oblate, infinite ways, by ſubſtituting determinate Quantities or Values inſtead of b and r. Thus you may contrive that the Points P and Q ſhall meet in C, by ſubſtituting 0 for b and r; and then the Section of the Torrent, will be compounded of two Oval Figures joined in C. You will find infinite Proportions between π, p and f, that will give this Figure.

If for Example, you would have the Points P and Q fall in C; you will have

$$2(n=1)\cdot\pi b^{m+1}=2(n+1)\pi c^{m+1}+2(m+1)$$

$pac^{m}-2qfabc^{m-1}-qfaac^{m-1}$. Whence you may deduce infinite Proportions between π, p and f.

If we ſuppoſe the Gravity as well towards γ as towards C, in a ſimple Proportion of the

Diſtance from the Center; the Section of the Torrent will be a Conic Section. And if it ſhould be moreover required that the Points, P, Q and C unite, the Figure will be compounded of two Ellipſes conjoined in C.

If the Diſtance Cγ vaniſhes, or if the two Centers unite, you will have $b=0$ and $c=a$, and the Torrent will become a Spheroid.

If moreover we ſuppoſe $m=n$ and $\pi=0$; the general Equation of the Section of the Torrent will become $2pr^{n+1}-(n+1)fa^{n-1}hhrr=(2p-nf-f)a^{n+1}$. Or in the Caſe of $n=-1$; $2pal\left(\frac{r}{a}\right)=\frac{fhhrr}{a}-fa$, as in the firſt Problem, which is but a particular Caſe of this.

CHAP. VIII.

Of the Figures of the Cœleſtial Bodies; of the Stars which ſeem to alter their Magnitude, and of Saturn's Ring.

ALL we have been ſaying is ſelf applicable to the Cœleſtial Bodies that turn about an Axis, if we ſuppoſe their parts to have taken the exact place which Gravity and the Centrifugal Force allotted them.

All the Planets, we know, are very nearly Spheres, excepting *Jupiter* whoſe Oblateneſs is conſiderable enough to be obſerved by Aſtronomers; but they are not therefore the leſs liable to all the Figures we have mentioned: There needs only leſs denſity in the Matter they are compounded of, or more Rapidity in their Revolution, to make them aſſume all theſe Figures: And why ſhould the kind of uniformity we ſee in ſome Planets prevent us from ſuſpecting, at leaſt, the variety of thoſe, the immenſity of the Heavens, perhaps, hides from our Sight. Confined to a corner of the Univerſe, with circumſcribed Intellects, why ſhould we bound Things to the little we perceive?

We have ſeen that Spheroids may aſſume infinite Figures, according to the Gravity of their parts and their Centrifugal Force; and that, in ſeveral Hypotheſes, a Planet may from a Spheroid the leaſt oblate, take on it the Figure of a Molary or Milſtone, or be reduced even to a circular Plane. Perhaps it is the diſtance only that hinders our ſeeing of ſuch Planets. But even without being at any very great diſtance from us, they may be hid from our Sight, if their Orbits happening to be in the Plane of the Ecliptic, or but a little diſtant from it, the Axis of their Revolution ſhould be perpendicular, or nearly ſo, to the ſame Plane. Suppoſing this, the Earth being always in the Plane, or nearly ſo, of the Equator of theſe Molaries, their thinneſs would conceal them from our Eyes.

Here then you have a new kind of Planets in the Heavens; at leaſt, ſuch there may be: But let us puſh the thought a little farther.

The fixed Stars are Suns like ours; it is very poſſible then, that like ours they revolve about an Axis. They muſt then according to the Rapidity of their Motion, be ſubject to a flat Form; and why ſhould there not be ſuch very oblate Stars in the Heavens? eſpecially if it be conſidered that we by no Obſervation have come at the preciſe Figure of the fixed Stars.

But again, it is very probable that the fixed Stars have their Planets that move round them, as our Sun has his.

If then any mighty and very excentric Planet or Comet ſhould go round a flat Star, in an Orbit inclined to the plane of the Equator of the Star, what would happen? The gravitation of the Star towards the Planet, when near its *Perihelion*, would alter the inclination of the ſaid Star, which muſt therefore appear more or leſs luminous. Such a Star even as we perceive not, becauſe its edge is towards us, will be viſible when it ſhews us a part of its diſc; and having made its appearance would diſappear again. Thus is it we may account for the change of Magnitude obſerved in ſome Stars, and for Stars that have appeared and diſappeared.

The Comets are no more, as we have ſeen, than very excentric Planets, ſome of which having bordered very near upon the Sun, leave him again, traverſing the Orbits of the more regular Planets, and then hold on their Journey through the different Regions of the Heavens.

When they return from their *Perihelion* they ſweep long Tails after them, and theſe Tails are immenſe Torrents of Vapour which the heat of the Sun has raiſed from them.

If a Comet in this State ſhould paſs by ſome mighty Planet, the force of Gravity towards the Planet might divert this Torrent, and bring it to circulate about itſelf, in the direction of ſome Ellipſis, or ſome Circle. And the Comet continuing to ſupply freſh Matter, or that already ſupplied, being ſufficient, a continued flux of Matter would be formed, or a kind of Ring about the Planet.

The Planet will attract the Matter of this Torrent in a reciprocal proportion to the Square of its diſtance; but, within the Torrent there will be a ſecond Gravitation of its parts mutually. In ſhort the parts of the Torrent will have ſtill a third Force, or a Centrifugal Force which they will acquire from their revolutionary Motion.

Now altho' the Body of Matter, that forms the Torrent, be at firſt Cylindrical, or Conic, or of any other Figure poſſible; it will neceſſarily aſſume ſome Figure bordering upon thoſe I have determined in the ſecond Problem. The Centrifugal Force will continually tend to flatten the Ring, and may be ſuch, as well with regard to the Gravitation towards the Planet, as of the parts mutually within themſelves, that the thickneſs of the Ring ſhall be very inconſiderable, in compariſon of its breadth.

In the mean time, the Body even of the Comet may be attracted alſo to the Planet, and be forced to move round it.

What I have here ſaid of oblate Planets that may perhaps be in the Syſtem of the

World, amounts to no more than to pretty probable conjecture on their exiſtence. Tho' theſe Planets are not obvious to the Sight, the Mind may conceive them, and from the Laws of Gravity conclude there may be ſuch.

And theſe conjectures concerning flat Stars, in particular, are rather the ſtronger, for that beſides the poſſibility of the Thing, *Phænomena* ſeem to inſinuate that there are in reality ſuch Stars in the Heavens.

But as for Torrents that circulate about Planets, we ſeem to have nothing but bare conjecture to ſupport us concerning them. We have ſight of a Planet, with regard to which every thing ſeems to have hapned as I have ſurmiſed; nor ought we to wonder if we ſaw Planets environed with ſeveral Rings like that of *Saturn.*

Theſe Rings ought rather to be formed around the great Planets than the ſmall, ſeing they are formed by Attraction which is ſtronger in the former than the latter: they ought alſo to be formed about the Planets far diſtant from the Sun rather than about thoſe that are nearer; becauſe, in thoſe diſtant parts, the velocity of the Comet ſlackens, and conſequently gives the Planet a longer time to exerciſe its power, and with the greater effect upon the Torrent or Tail.

Nor is this a little confirmed by Experience; the only Planet we ſee begirt with a

Ring, is one of the largeſt, and the fartheſt diſtant from the Sun.

The number of *Satellites* belonging to *Saturn* and the vaſtneſs of his Ring, may make us fancy he acquired them at the Expence of ſeveral Comets. In truth, this Ring, as thin as it ſeems to be, muſt be formed of a prodigious quantity of Matter to be able to caſt ſuch a ſhadow upon the diſc of its Planet, as is obſerved by Aſtronomers; while the Tails of the Comets are ſo very rare, that you commonly ſee the Stars through them; but indeed the Gravitation the Matter of theſe Tails acquires towards the Planet that might divert them, and force them to fluctuate about it, muſt condenſe them.

As for the Planets that have *Satellites* and no Ring; it is plain that the Tail of a Comet being merely accidental, and common only to thoſe that have been very near the Sun, a Comet without a Tail may become the *Satellite* of a Planet, without communicating a Tail to it. It is poſſible alſo that a Planet may acquire a Ring without a *Satellite*, if the Planet is at that diſtance from the Comet, that it can only attract the Tail to it.

The matter that forms theſe Rings, inſtead of being ſuſtained as a Vault at a certain diſtance, may every way overflow the Body about which it revolves, and form a kind of oblate Atmoſphere; and what may happen to the Planets, may in like manner happen to the fixed Stars. It is to ſuch an Atmoſphere about the Sun, that they attribute the light *Caſſini* * obſerved in the *Zodiac.*

Sir *Iſaac Newton* has obſerved that the Vapour of the Comets might ſpread itſelf over the Planets that ſhould be near enough; and thinks this kind of Communication to be of uſe in reſtoring the Planets to the Humidity they inceſſantly loſe. He even thinks the Comets may fall into the Sun or into the Stars; and thus it is he explains how it is that a Star ready to go out, ſupplied with ſuch Fewel ſhines forth again with its firſt ſplendor. The famous *Engliſh* Philoſophers, Dr. *Halley*, and Mr. *Whiſton*, have taken notice that if a Comet ſhould interfere with our Earth, terrible accidents might enſue, a change of Poles, Subverſion, Deluge, and Conflagration; but inſtead of theſe fatal Cataſtrophes, the meeting with Comets might be productive of new wonders, and Things greatly uſeful to our Earth.

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* *Mem. de l'Acad. des Sciences depuis* 1666, *juſqu'a* 1699. Tom. VIII. *Seconde Edition.*

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